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Handbook
of
Textile Testing

BUREAU OF INDIAN STANDARDS

HANDBOOK
OF
TEXTILE TESTING

Part 3 Testing of Textile Products other than Yarns and Fabrics

(First Revision)

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
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FOREWORD

This part of the Handbook consists of nine sections including one General section containing test methods which are fundamental and general in nature and applicable to test methods under various sections of this Handbook. Each section of this Handbook covers the methods of tests relating to a particular group. Sections 'A' to 'J' of this Handbook contains various test methods on testing of textile products other than yarns and fabrics.

The brief details about the above mentioned sections are as given below:

Section A contains test methods which are general in nature and have been referred in the test methods included in the subsequent sections.

Section B contains test methods for various types of ropes and cordage. The test methods for characteristics such as diameter, circumference, mass, length, linear density, lay, breaking load and elongation at break which are essential for laying down the yard-stick of performance of these products from point of view of their end use.

Industrial safety nets and cargo handling nets are used in places where safety of very high order is essential. Keeping this in view, the performance test methods such as drop test and proofload test have been included.

Section C contains various test methods for rubberized coir sheets for cushioning for such characteristics as dimensions, density, indentation hardness, resistance to ageing, resistance to flexing compression set, *p*H value, chloride content and sulphate content. These are essential for introducing quality parameters for these characteristics in a consumer oriented product specification. It also includes method of tests for coir mats for characteristics such as dimensions, ends and picks/dm, mass, pile height and construction and also include test methods for mattings, mourzouks and carpets for the characteristics such as dimensions, ends and picks/dm and mass.

Section D contains test methods on various floor coverings such as woollen druggets, hand-made namdhas, hand-made woollen carptets and tufted wool carpets. Some of the important test methods for determining the performance of these products such as determination of type of knots, number of knots, pile height and dimensions have been included in this section.

Section E contains test methods for various characteristics of tyre yarn, cords and tyre cord fabrics made from man-made fibres such as linear density, breaking load, elongation at break and tenacity, dip pick up heat shrinkage and heat shrinkage force, wet contraction and wet contractile force, heat degradation, thickness, growth and commercial weight. Also it contains test method for thickness characteristic of jute needle loom felt.

Section F contains test methods for fishing gear materials which are mainly used in coastal and deep sea fishing where performance of the fishing gear material is of utmost importance. The test methods for examining the important characteristics of fishing gear materials such as thickness, linear density, twist, breaking load and knot breaking load, mesh breaking load, change in length of netting yarns after immersion in water, elongation of netting yarns, sinking speed and cutting rate have been included in this section.

Section G contains test methods for determining the essential characteristics such as mass, wales, courses, dimensional change due to relaxation, dimensional change due to felting and scouring loss of gloves, wool, knitted (hosiery product).

Section H contains test methods for determining the characteristics of monoxially oriented high density polyethylene or polypropylene tapes such as linear density, width, thickness, breaking load, tenacity, extension, heat shrinkage which have a direct bearing on their end use performance.

Section J contains test methods for various performance characteristics of textile materials for aerospace purposes. Since the end-uses of the most of the aerospace textiles needed safety and performance requirement of very high order, the test methods of various characteristics have been oriented, accordingly.

The various methods of test included in this part are based on the current national and international practices.

The test methods pertaining to various standards included in this part have been brought out by the following Sectional Committees under TXDC:

TXD 1 : Physical methods of test
TXD 9 : Cordage
TXD 10 : Hosiery
TXD 12 : Narrow fabrics, webbings and braids
TXD 13 : Textile materials for aerospace purposes
TXD 16 : Textile floor coverings
TXD 18 : Textile materials for marine/fishing purposes
TXD 23 : Textile materials made from polyolefins (excluding cordage)
TXD 24 : Industrial/Engineering fabrics
TXD 25 : Coir and coir products

INTRODUCTION

BIS Handbook of Textile Testing (SP 15 : 1981) was first published in 1982 and has been taken up for revision to incorporate new standards which have come out after its publication. Opportunity has also been taken to incorporate the new versions of the standards which have since been revised to meet the popular demand. The Handbook is now being brought out in four parts wherein standards have been grouped on the basis of application and use:

Part 1	Testing and Grading of Textile Fibres
Part 2	Testing of Yarns and Fabrics (Excluding Colour Fastness)
Part 3	Testing of Textile Products Other Than Yarns and Fabrics.
Part 4	Identification and Testing of Dyestuffs and Their Colour Fastness on Textile Materials

The Handbook is basically a compilation of various Indian Standards on methods of test published by various Sectional Committees under Textile Division Council. There are more than 300 standards covering a wide range of physical and chemical characteristics of textiles besides compilation from the product standards covering methods of test. Such methods of test for which separate standards have not been published and which are included in the product specifications: these methods of test have been extracted from these product standards and included in the present version of the Handbook wherever appropriate. The methods of test included in the Handbook would now be able to satisfy the requirement of various sectors of textile industry like testing laboratories, research institutions, educational institutions in as far as the testing of the products like handloom and khadi, powerloom, hosiery, carpets, readymade garments, dyestuffs, textile auxiliaries, ropes and cordage, industrial textiles, aerospace textiles, etc, is concerned.

The objects of the Handbook are to:

- give the user first-hand information on all published national standards on methods of test for textile and their use;
- help the various users to establish a suitable quality assurance system in the organization;
- serve as a guide for the ordinary consumer to know what characteristics of textile are important for its best use and care; and
- assist the textile students, educational and research institutions in the selection of the methods of test for effective studies and research.

Representation of information in the Handbook has been organized in the following manner:

a) Identification and grading of various textile fibres and yarns;

b) Quantitative chemical analysis and tests for various physical and chemical characteristics of textile fibres;

c) Identification and strength of various dyestuffs used for textiles;

d) Colour fastness properties of coloured textiles towards various agencies such as light, washing, heat, perspiration, hot water, dry cleaning, etc;

e) Code of practice for stains removal from textiles and clothings;

f) Tests for various physical and chemical characteristics of yarns and fabrics such as strength parameters, dimensional stability, water repellency, soil resistance, flame resistance, flammability, biological degradation, etc;

g) Tests for various sizing and finishing treatments;

h) Care labelling and positioning of labels in garments; and

j) Tests for ropes and cordages, coir products, textile floor coverings, industrial textiles, fishing gear materials, hosiery products, tapes, webbings, narrow fabrics and aerospace textiles.

Every effort has been made to make the various parts and sections self-contained but in certain cases relevant provisions have been extracted and reproduced. In all such cases, for detailed guidance, reference should be made to individual standards and in case of any contradiction observed between the Indian Standards and those reproduced herein; the provisions of the former should be considered accurate. The need of the Handbook is to make it a self-contained as a reference document, whereas on the other hand the need is to keep it less voluminous. The present version of the Handbook is the judicious choice with respect to the two aspects referred above.

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SECTION A

GENERAL

CONDITIONING OF TEXTILES

(*Source* : IS 6359 : 1971)

Most of the textiles being hygroscopic in nature, the relative humidity and temperature of the atmosphere affect their physical and mechanical properties appreciably. In order that reliable comparisons may be made among different materials and products and among different laboratories, it is necessary to standardize the humidity and temperature conditions and the procedure by which the textile material may be brought to the moisture equilibrium before testing.

1 SCOPE

1.1 This standard prescribes a procedure for conditioning of all textile materials.

1.1.1 This standard also prescribes a procedure for pre-conditioning of textiles which would be necessary if specified in the standard test method or specification for the material under test before conditioning.

2 PRINCIPLE

2.1 The principle followed is to allow the textile material to remain in the conditioning room during its absorption cycle for a sufficient time to reach moisture equilibrium.

3 TERMINOLOGY

3.1 Atmospheric Conditions for Testing (Standard)

The atmosphere in which physical tests on textile materials are performed. It has a relative humidity of 65 ± 2 percent and a temperature of 27 ± 2°C.

3.2 Moisture Equilibrium

The condition reached by a sample or specimen in a controlled atmosphere when the net difference between the amount of moisture absorbed and the amount desorbed, as shown by a change in weight, shows no trend and becomes insignificant.

3.3 Moisture Equilibrium for Testing

The condition reached by sample or specimen during free exposure to moving air controlled at specified conditions. For test purposes, moisture equilibrium shall be reached by absorption, starting from, a relatively low moisture content. Moisture equilibrium for testing is considered to have been reached when successive weighings carried out at intervals of not less than 2 hours of the textile materials freely exposed to the moving air differ by less than 0·25 percent.

3.4 Preconditioning

To bring a sample or specimen to a relatively low moisture content [equilibrium in an atmosphere between 10 and 25 percent RH and not exceeding 50°C (*see* Note)] prior to conditioning in a controlled atmosphere for testing. (While preconditioning is frequently translated as predrying, specimens should not, in fact, be brought to the oven-dry state.)

NOTE — These conditions may be obtained by heating air at 65 percent RH and 27 °C (the standard atmosphere) to a temperature up to 50°C in air circulating type oven.

3.5 Relative Humidity

The ratio of the actual pressure of the water vapour in the atmosphere to the saturation vapour pressure at the same temperature. The ratio is usually expressed as a percentage.

NOTE — Under normal circumstances, the sling or whirling hygrometer or Assmann's are the most convenient instruments for measuring relative humidity, they are sufficiently accurate for this purpose.

4 APPARATUS

4.1 Conditioning Room or Chamber

Equipped with apparatus capable of maintaining standard atmosphere for conditioning and testing throughout the room or chamber within the specified tolerances of relative humidity and temperature and having arrangements for maintenance of proper air circulation (*see* 3.1).

4.1.1 It shall also be equipped with the instruments for recording relative humidity and temperature.

4.2 Preconditioning Cabinet or Room

Equipped with apparatus capable of maintaining atmosphere for preconditioning of textiles throughout the room or chamber within the specified tolerances of relative humidity and temperature (*see* 3.4).

4.3 Balance

Capable of weighing to an accuracy of 0·25 percent.

5 PROCEDURE

5.1 Determine the relative humidity and temperature of the conditioning room or chamber (*see* 4.1) and, if preconditioning is also to be carried out, find the relative humidity and temperature of the preconditioning cabinet or room to check whether the conditions meet the specified values of relative humidity and temperature or not. If the conditions are not as required, make adjustments to bring them to the desired limits of temperature and humidity.

5.1.1 If both preconditioning and conditioning are prescribed in the test method or the specification for the material, proceed as given in 5.2 and 5.3, and if only conditioning has been prescribed, omit 5.2.

5.2 Expose the specimen or sample in the atmosphere for preconditioning in such a way as to expose, as far as possible, all portions of the material to the for preconditioning in such a way as to expose, as far as possible, all portions of the material to the atmosphere until the moisture equilibrium is attained (*see* Note 1 under 5.3).

5.3 Expose the specimen or sample (already preconditioned, if so required) in the standard atmosphere in such a way as to expose, as far as possible, all portions of the material to the atmosphere until the moisture equilibrium is attained (*see* Notes).

NOTES

1 In case the material received is in package from, it is preferable to prepare test specimens in loose or open form so that all portions get uniformly exposed to the preconditioning or conditioning atmospheres. For example, in case of yarn in the form of cones or cheeses, suitable skeins may be prepared for conditioning.

2 For guidance purposes, it may be noted that the minimum time required for the various types of textile materials having moisture regain valuables of less than 5 percent is about 6 hours to reach moisture equilibrium while for those having moisture regain values of more than 5 percent it is 24 hours.

5.4 The textile materials conditioned as above be tested according to the procedure laid down.

CONVERSION FACTORS FOR YARN COUNTS

(*Source* : IS 3689 : 1966)

1 SCOPE

1.1 This standard defines the various count systems and provides factors and formulae for inter-conversion of yarn counts. Tables for inter-conversion of values in traditional count systems and Tex System are also included in this standard.

2 DEFINITIONS

2.1 Direct System

The count system in which the size of the yarn is expressed in terms of the mass of yarn per unit length.

2.2 Indirect System

The count system in which the size of the yarn is expressed in terms of the length of yarn per unit mass.

3. CONVERSION FACTORS

Table 1 Conversion Factors for Direct Systems and Tex

Sl No.	Yarn Count System	Symbolic Abbreviation	Unit Mass Used	Unit of Length Used	Unit of Yarn Count	Conversion Factors	
						To Other Yarn Counts from Tex	To Tex from Other Yarn Counts
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
i)	Tex	Tt	1 g	1 000 m	g/1 000 m	–	–
ii)	Denier	Td	1 g	9 000 m	g/9 000 m	$Td = 9\ Tt$	$Tt = 0.111\ 1\ Td$
iii)	Grist [Jute, Hemp, Linen (dry spun)]	T_j	1 lb	14 400 yd (spindle unit)	lb/14 400 yd	$Tj = 0.029\ 03 Tt$	$Tt = 34.45\ Tj$

Table 2 Conversion Factors for Indirect Systems and Tex

Sl No.	Yarn Count System	Symbolic Abbreviation	Unit of Length Used	Unit of Mass Used	Unit of Yarn Count	Conversion Factors	
						To Other Yarn Counts from Tex	To Tex from Other Yarn Counts
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
i)	Cotton count (spun rayon staple, spun silk)	NeC	840 yd (hank)	1 lb	840 yd/lb	$NeC = \frac{590.5}{Tt}$	$Tt = \frac{590.5}{NeC}$
ii)	Linen (wet spun)	NeL	300 yd (*lea*)	1 lb	300 yd/lb	$NeL = \frac{1\ 654}{Tt}$	$Tt = \frac{1654}{NeL}$
iii)	Metric (cottoh and wool)	Nm	1 000 m (hank)	1 kg	1 000 m/kg	$Nm = \frac{1\ 000}{Tt}$	$Tt = \frac{1000}{Nm}$
iv)	Woollen (Dewsbury)	Nd	1 yd	1 oz	yd/oz	$Nd = \frac{31\ 000}{Tt}$	$Tt = \frac{31\ 000}{Nd}$
v)	Woollen (Yorkshire)	Ny	256 yd (skein)	1lb	256 yd/lb	$Ny = \frac{1\ 938}{Tt}$	$Tt = \frac{1\ 938}{Ny}$
vi)	Worsted	NeW	560 yd (hank)	1 lb	560 yd/lb	$NeW = \frac{885.8}{Tt}$	$Tt = \frac{885.8}{New}$

Table 3 Conversion Formulae for Inter-Conversion of Yarn Counts

Yarn Counts	Tex (T_t)	Denier (T_d)	Grist [Jute, Linen (Dry Spun), Hemp] (T_j)	Cotton Count (Spun-Rayon Staple, Spun Silk) (N_{eC})	Linen (Wet Spun) (N_{eL})	Metric (N_m)	Woollen (Dewsbury) (N_d)	Woollen (Yorkshire) (N_y)	Worsted (N_{eW})
		(Direct to Direct System)					(Direct to Indirect System)		
Tex (T_t)	T_t	$T_d = 9 \times T_t$	$T_j = 0{\cdot}029\,03 \times T_t$	$N_{eC} = \frac{5905}{T_t}$	$N_{eL} = \frac{1\,654}{T_t}$	$N_m = \frac{1\,000}{T_t}$	$N_d = \frac{31\,000}{T_t}$	$N_y = \frac{1\,938}{T_t}$	$N_{eW} = \frac{8858}{T_t}$
Denier (T_d)	$T_t = 0{\cdot}111\,1 \times T_d$	T_d	$T_j = 0{\cdot}003\,225 \times T_d$	$N_{eC} = \frac{5\,315}{T_d}$	$N_{eL} = \frac{14\,880}{T_d}$	$N_m = \frac{9\,000}{T_d}$	$N_d = \frac{279\,000}{T_d}$	$N_y = \frac{17\,440}{T_d}$	$N_{eW} = \frac{7\,972}{T_d}$
Grist [jute, linen (dry spun), Hemp] (T_j)	$T_t = 34{\cdot}45 \times T_j$	$T_d = 310 \times T_j$	T_j	$N_{eC} = \frac{1714}{T_j}$	$N_{eL} = \frac{48{\cdot}00}{T_j}$	$N_m = \frac{29{\cdot}03}{T_j}$	$N_d = \frac{89{\cdot}99}{T_j}$	$N_y = \frac{56{\cdot}25}{T_j}$	N_{eW} $\frac{25{\cdot}71}{T_j}$
		Indirect to Direct System					*(Indirect to Indirect System)*		
Cotton count (spun-rayon staple spun silk) (N_{eC})	$T_t = \frac{5905}{N_{eC}}$	$T_d = \frac{5\,315}{N_{eC}}$	$T_j = \frac{1714}{N_{eC}}$	N_{eC}	$N_{eL} = 2.80 \times N_{eC}$	$N_m = 1{\cdot}693 \times N_{eC}$	$N_d = 5{\cdot}250 \times N_{eC}$	$N_y = 3{\cdot}281 \times N_{eC}$	$N_{eW} = 1{\cdot}50 \times N_{eC}$
Linen (wet spun) (N_{eL})	$T_t = \frac{1\,654}{N_{eL}}$	$T_d = \frac{14\,880}{N_{eL}}$	$T_j = \frac{48.00}{N_{eL}}$	N_{eC} $0{\cdot}357\,1 \times N_{eL}$	N_{eL}	$N_m = 0.604\,8 \times N_{eL}$	$N_d = 18.74 \times N_{eL}$	$N_y = 1{\cdot}172 \times N_{eL}$	$N_{eW} = 0{\cdot}537 \times N_{eL}$
Metric (N_m)	$T_t = \frac{1\,000}{N_m}$	$T_d = \frac{9\,000}{N_m}$	$T_j = \frac{29{\cdot}03}{N_m}$	$N_{eC} = 0{\cdot}590\,5 \times N_m$	$N_{eL} = 1{\cdot}654 \times N_m$	N_m	$N_d = 31{\cdot}00 \times N_m$	$N_y = 1{\cdot}938 \times N_m$	$N_{eW} = 0{\cdot}885\,8 \times N_m$
Woollen (Dewsbury) (N_d)	$T_t = \frac{31\,000}{N_d}$	$T_d = \frac{279\,000}{N_d}$	$T_j = \frac{89{\cdot}99}{N_d}$	$N_{eC} = 0{\cdot}019\,05 \times N_d$	$N_{eL} = 0{\cdot}053\,35 \times N_d$	$N_m = 0{\cdot}032\,26 \times N_d$	N_d	$N_y = 0{\cdot}062\,52 \times N_d$	$N_{eW} = 0{\cdot}028\,57 \times N_d$
Woollen (Yorkshire) (N_y)	$T_t = \frac{1\,938}{N_y}$	$T_d = \frac{17\,440}{N_y}$	$T_j = \frac{56{\cdot}25}{N_y}$	$N_{eC} = 0.304\,8 \times N_y$	$N_{eL} = 0{\cdot}853\,3 \times N_y$	$N_m = 0{\cdot}516\,1 \times N_y$	$N_d = 16{\cdot}00 \times N_y$	N_y	$N_{eW} = 0{\cdot}457\,1 \times N_y$
Worsted (N_{eW})	$T_t = \frac{8858}{N_{eW}}$	$T_d = \frac{7\,972}{N_{eW}}$	$T_j = \frac{25.71}{N_{eW}}$	$N_{eC} = 0{\cdot}666\,7 \times N_{eW}$	$N_{eL} = 1{\cdot}867 \times N_{eW}$	$N_m = 1{\cdot}129 \times N_{eW}$	$N_d = 35{\cdot}00 \times N_{eW}$	$N_y = 2{\cdot}188 \times N_{eW}$	N_{eW}

PREPARATION OF TEST SPECIMENS FROM FABRIC SAMPLES FOR PHYSICAL TESTS

(*Source*: **IS 6668 : 1972**)

For the test results to be reproducible and to have a meaningful interpretation, use of a proper method for preparing test specimens from the laboratory samples is as important as that of a proper method for drawing representative samples from the lot and a proper method of test. This method is based on the practices prevailing in the textile industry.

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1 SCOPE

1.1 This standard prescribes method for preparing test specimens from fabric samples for the purpose of testing various physical characteristics.

1.1.1 This standard is applicable to all types of fabrics, namely, woven, knitted, felted and nonwoven, made from any type of fibre.

2 TERMINOLOGY

2.0 For the purpose of this standard, the following definitions shall apply.

2.1 Test Sample

A representative sample drawn from a lot for the purpose of preparing test specimens for testing.

2.2 Test Specimen

A specific portion of a test sample upon which a single test is performed or which is selected for that purpose.

3 PROCEDURE

3.1 Woven Fabrics

3.1.1 Take one of the test samples drawn for the purpose of preparing test specimens, mark the warp and weft direction and lay it flat on the surface of a smooth table. Remove any wrinkles or folds in the sample by hand without unduly stretching it.

3.1.2 Mark the required number of warpway and weftway test specimens of the required size from different portions of the sample under test. The length directions of the warpway and weftway test specimens shall be parallel to the warp and weft directions of the sample respectively. The specimens marked in each direction shall be scattered throughout the area of the sample (*see* Fig.1 A) in such a way that:

a) no two warpway specimens contain the same set of warp yarns, and

b) no two weftway specimens contain the same set of weft yarns.

3.1.2.1 However, in case it is not possible to have different sets of warp or weft yarns for different specimens, a portion of the warp or weft yarns taken in one specimen may be allowed to form a part of the other (*see* Fig. 1B).

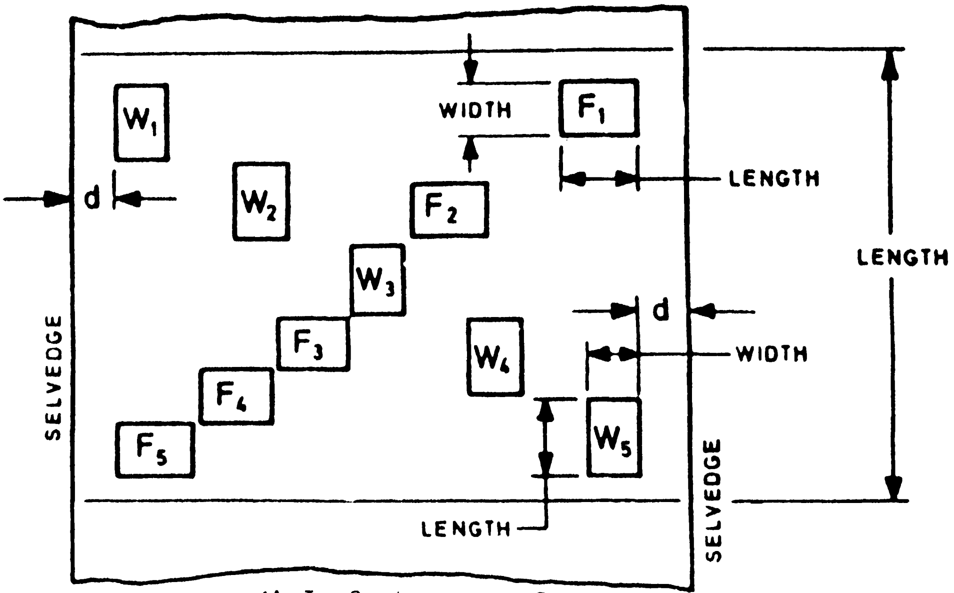
3.1.2.2 The number of test specimens to be drawn and the size of each specimen depends on the characteristic to be tested and shall be as laid down in the specification for the material or the method of test to be followed. In case there are more than one test sample for drawing test specimens, draw approximately equal number of specimens from each test sample to make up the total number of test specimens.

3.1.2.3 Avoid taking test specimens from the portions having wrinkles, folds or defects. Do not take any specimen within one-tenth of the fabric width from the selvedge. Mark the warpway and weftway test specimens with the letters 'W' and 'F' respectively for the purpose of identification.

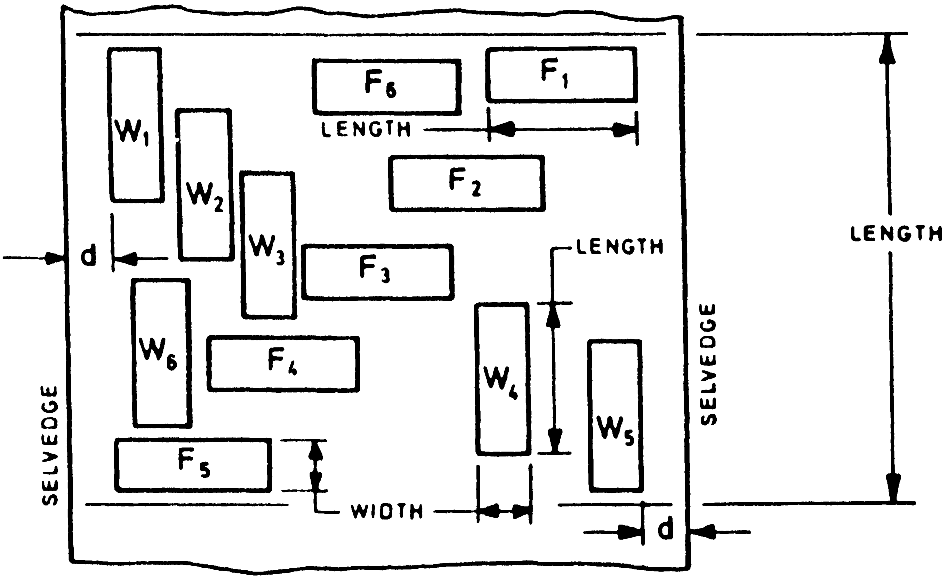
3.1.3 Cut with the help of a sharp razor or a pair of scissors the test specimens along the markings and collect the warpway and weftway specimens separately.

3.2 Other Fabrics

In the case of knitted, felted and nonwoven fabrics, the length and width directions should be treated as warp and weft directions respectively as in the case of woven fabrics and the test specimens prepared as above.



1A Test Specimens without Common yarns (or Portions)



1B Test Specimens with Common Yarns (or Portions)

W = Warpway test specimen

F = Weftway test specimen

NOTE — Distance *d* Shall be not less than one-tenth of fabric width

FIG. 1 LAYOUT OF TEST SPECIMENS

PREPARATION OF LABORATORY TEST SAMPLES AND TEST SPECIMENS OF TEXTILE MATERIALS FOR CHEMICAL TESTING

(*Source* : IS 9022 : 1979)

This standard prescribes the methods in which the laboratory test samples are obtained by the combination of numerous small portions each drawn from a different part of the laboratory bulk sample. Therefore, any results obtained on test specimens from these samples will estimate the mean level in the laboratory bulk sample but will not indicate the variability of level from portion to portion of the laboratory bulk sample. Consequently it is appropriate to use this method in cases where it is desired to estimate the bulk composition, for example, the proportions of different fibres in a blend, but it is not appropriate in cases where variability is important, for example, in the determination of *p*H where the local value is significant, or in the determination of fungicides, where a high value in one area of the material does not compensate for low value elsewhere. Also, it may not be appropriate for use in determination of commercial mass values.

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1 SCOPE

1.1 This standard specifies methods of obtaining laboratory test samples of textile materials from laboratory bulk samples taken from a bulk source and gives general directions for the preparation of test specimens of convenient size for chemical test.

1.2 No provision for sampling from the bulk source is described since it is assumed that the laboratory bulk sample has been selected by a suitable procedure and is representative of the bulk source.

2 DEFINITIONS

2.0 For the purpose of this standard, the following definitions shall apply.

2.1 Bulk Source

That quantity of material which is to be judged on the basis of one series of test results. This may comprise, for example, all the material in one delivery of cloth; all the cloth woven from a particular beam; a consignment of yarn; a bale or a group of bales of raw fibre.

2.2 Laboratory Bulk Sample

That portion of the bulk source taken to be representative of the whole. The size and nature of the laboratory bulk sample should be sufficient to overcome adequately the variability of the bulk source and to facilitate ease of handling in the laboratory.

2.3 Laboratory Test Sample

That portion of the laboratory bulk sample from which specimens are taken for testing. The size and nature of the laboratory test sample should be sufficient to overcome adequately the variability of the laboratory bulk sample.

2.4 Test Specimen

The portion of material required to give an individual test result.

3 PRINCIPLE

3.1 The laboratory test sample is taken so that it is representative of the laboratory bulk sample. The test specimens are taken from the laboratory test sample in such a way that each of them is representative of the laboratory test sample.

4 SAMPLING OF LOOSE FIBRES

4.1 Non-oriented Fibres

4.1.1 If the laboratory bulk sample consists of less than 5 kg of loose fibre, spread it out in an even layer. Obtain the laboratory test sample by taking at random a minimum of 100 tufts of approximately equal size, the total mass being sufficient to give a laboratory test sample of required size.

4.1.2 If the laboratory bulk sample is greater than 5 kg, divide it into a number of equal portions, and take an equal number of tufts of suitable mass from each portion such that the total number from all portions exceed 100.

4.1.3 Pretreat the laboratory test sample, if required, by the test method to be used. From the laboratory test sample remove at random, using forceps, small tufts of approximately equal mass to give a test specimen of the mass required.

4.2 Oriented Fibres (Card Webs, Slivers, Rovings)

From randomly selected parts of the laboratory bulk sample cut not less than ten cross sections each weighing approximately 1 g. After applying pretreatment, if necessary, lay the cross-sections together and obtain the test specimen by cutting through them so as to take a portion of each of the ten lengths.

5 SAMPLING OF YARN

5.1 Yarn in Packages or in Hanks

5.1.1 If the number of packages in the laboratory bulk sample is 25 or less, sample all the packages. If the number exceeds 25, take 25 packages at random. If the linear density of the yarn, expressed in tex, is t, and the number of packages taken from the laboratory bulk sample is n, the length of yarn from each package to give a 10 g laboratory test sample is:

$$\frac{10^6}{n \times t} \text{ cm}$$

if $n \times t$ is high, for example, more than 2 000, wind a heavier skein and cut it across in two places to make a tow of suitable mass.

5.1.2 Withdraw the appropriate continuous length from each package either by winding skeins of the same number of turns on a wrap reel (*see* Note) or by some other means. Unite the length side by side either as a single skein or as a tow to form the laboratory test sample, ensuring that there are equal lengths from each package in the skein or tow. Pretreat the laboratory test sample, if required, by a suitable method and ensure that the ends of any sample in the form of tow are securely tied before treatment.

NOTE — If the packages can be mounted in a convenient creel a number can be wound simultaneously.

5.1.3 Take specimens of the appropriate mass from the laboratory test sample by cutting a bunch of threads of equal length from the skein or tow and comprising all the threads in it, ensuring that test specimens are taken from a place remote from the tie bands.

5.2 Yarn on Warp

5.2.1 Take the laboratory test sample by cutting a length from the end of the warp, not less than 20 cm long and comprising all the yarns in the warp except the selvedge yarns, which are rejected. Tie the bunch of threads together near one end. If the sample is too large for any required pretreatment, divide it into two or more portions, each portion tied together separately for pretreatment. Reunite the portions after the pretreatment.

5.2.2 Take a test specimen by cutting a suitable length from the laboratory test sample from the end remote from the tie band, and comprising all the threads in the warp. For warp of N threads of tex t, the length of a specimen of mass 1 g is:

$$\frac{10^5}{n \times t} \text{ cm}$$

6. SAMPLING OF FABRIC

6.1 From a Laboratory Bulk Sample Consisting of a Single Cutting Up to 1 m in Length

6.1.1 Cut a diagonal strip from corner to corner and remove the selvedges. For a laboratory test sample of x g the area of the strip required is:

$$\frac{x \times 10^4}{M} \text{ cm}^2$$

where M is the mass of the cloth in g/m^2.

6.1.2 This area divided by the length of the diagonal in centimetres will give the required width of strip in centimetres.

6.1.3 After subjecting the strip to any pretreatment, cut it across its length into four equal lengths and superimpose them. Take test specimens from any part of the layered material by cutting through all the layers in such a way that each specimen comprises an equal length from each layer.

6.2 From a Laboratory Bulk Sample Consisting of a Single Cutting More Than 1 m in Length

Take two full-width cuttings, one from each end of the laboratory bulk sample and not more than 1 m long. Cut both into two equal portions by a cut parallel to the warp direction and mark the right-hand and left-hand halves of each. Put the right-hand half of one cutting to the left-hand half of the other, with the cut edges together, and cut a diagonal strip from the lower corner of one cutting to the upper corner of the other, after removing the selvedges. Proceed as in **6.1**, treating the two half-width diagonal strips as if they were a full-width continuous strip.

6.3 From a Laboratory Bulk Sample Consisting of Several Cuttings

Treat each cutting separately as described in **6.1** or **6.2** and give results for each cutting in the test report.

6.4 From a Fabric with a Design Arising from the Distribution of Threads

6.4.1 Ensure, if possible, that there is an integral number of complete repeats of the design in the laboratory bulk sample and proceed as in **6.1** unless the laboratory bulk samples so obtained is more than 1 m in length in which case proceed as in **6.2**. Where the pattern repeat is large and/or asymmetric, the entire strip should be cut into small fragments, thoroughly mixed and then sampled by the procedure indicated in **4.1**.

6.4.2 Where the laboratory bulk sample does not contain at least one complete repeat of the design, report this under **8.1** (b).

7 SAMPLING OF MADE-UP ARTICLES

7.1 The laboratory bulk sample normally consists of a complete made-up article or a representative part of such an article.

7.2 Determine whether all parts of the article are of similar composition; if so, treat the whole article as a laboratory bulk sample, and take a laboratory test sample representative of the laboratory bulk sample.

7.3 If parts of the article are of different composition, separate the parts and treat each as the laboratory bulk sample and take a laboratory test sample representative of the laboratory bulk sample.

8 TEST REPORT

8.1 The test report should include the following information:

a) A statement that the material was sampled in accordance with this standard,

b) The size of the laboratory bulk sample (*see also* **6.4.2**),

c) The size of the laboratory test sample, and

d) The size of the test specimen.

RECOMMENDED SI UNITS FOR TEXTILES

(*Source* : SP 11 : 1973)

In textile trade and industry the measurement of various characteristics plays an important role in the analysis, quality control, sale-purchase and checking up for compliance to the standard. For easy understanding and interpretation of figures by different interests, it becomes essential to changeover to a unified set of units which have been accepted at national as well as international level. This publication has, therefore, been issued for the guidance of users for changing over to SI system, with a view to unifying the set-up of units in various facets of textile trade and industry. Wherever the SI units differ from metric units, the metric units with which the industry is familiar have also been given.

1 SCOPE

1.1 This publication contains a list of SI units recommended for use in the textile industry and trade.

2 TERMINOLOGY

2.1 Newton (N)

Force which, when applied to a body having a mass of one kilogram, gives it an acceleration of 1 m/s:

1 millinewton (mN) = 10^{-3} N (newton)

1 kilogram force (kgf) = 9·806 65 N (newton)

1 gramforce (gf) = 9·806 65 mN (millinewton)

3 LIST OF UNITS

3.1 Table 1 lists the characteristics, SI-units (their metric equivalents, wherever necessary), abbreviations and their fields of application.

Table 1 Recommended SI Units for Textiles

(*Clause* 3.1)

SI No.	Property	SI Units		Metric Units		Application
		Unit	Abbreviation	Unit	Abbreviation	
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1.	Length	Millimetre	mm	—	—	Fibres
		Millimetre, centimetre	mm, cm	—	—	Samples and test specimens (as appropriate)
		Metre	m	—	—	Yarns, ropes and cordages, fabrics
2.	Width	Millimetre	mm	—	—	Narrow fabrics
		Centimetre	cm	—	—	Other fabrics
		Millimetre, centimetre	mm, cm	—	—	Samples and test specimen (as appropriate)
		Centimetre, metre	cm, m	—	—	Carpets, druggets, durries (as appropriate)
3.	Thickness	Micrometre (micron)	µm	—	—	Delicate fabrics
		Millimetre	mm	—	—	Other fabrics, carpets felts
4.	* Linear density	Tex	tex	—	—	Yarns
		Millitex	mtex	—	—	Fibres
		Decitex	dtex	—	—	Filament and filament yarns
		Kilotex	ktex	—	—	Slivers, ropes and cordages
5.	Diameter	Micrometre (micron)	µm	—	—	Fibres
		Millimetre	mm	—	—	Yarns, ropes, cordages
6.	Circumference	Millimetre	mm	—	—	Ropes, cordages
7.	Threads in cloth:					
	Length	Number per centimetre	ends/cm	—	—	Woven fabrics (as appropriate)
		Number per decimetre	ends/dm			
	Width	Number per centimetre	picks/cm	—	—	
		Number per decimetre	picks/dm			

*For conversion of values in traditional counts to the tex and vice versa, reference to IS: 3689-1966 'Conversion factors and conversion tables for yarn counts' shall be made.

Table 1 *(Concluded)*

Sl No.	Property	SI Units		Metric Units		Application
		Unit	Abbreviation	Unit	Abbreviation	
(1)	(2)	(3)	(4)	(5)	(6)	(7)
8.	Warp threads in loom	Number per centimetre	ends/cm	—	—	Reeds
9.	Stitches in cloth:					
	Length	Number per centimetre Number per decimetre	courses/cm courses/dm	—	—	Knitted fabrics (as appropriate)
	Width	Number per centimetre Number per decimetre	wales/cm wales/dm	—	—	
10.	Stitch length	Millimetre	mm	—	—	Knitted fabrics Made-up fabrics
11.	Mass per unit area	Grams per square metre	g/m^2	—	—	Fabrics
12.	Mass per unit length	Grams per metre	g/m	—	—	Fabrics
13.	Twist	Turns per centimetre Turns per metre	turns/cm turns/m	— —	— —	Yarns, ropes (as appropriate)
14.	Test or gauge length	Millimetre, centimetre	mm,cm	—	—	Fibres, yarns and fabric specimens (as appropriate)
15.	Breaking load	Millinewton	mN	grams force	gf	Fibres, delicate yarns (skeins or individual),
		Newton	N	kilogram force	kgf	Strong yarns (individual or skeins), ropes and cordages, fabrics
16.	Breaking length	Kilometre	km	—	—	Yarns
17.	Tenacity	Millinewton per tex	mN/tex	grams force per tex	gf/tex	Fibres, yarns (individual or skeins)
18.	Twist factor or twist multiplier	Turns per centimetre × square root of tex Turns per metre × square root of tex	turns/cm $\times \sqrt{tex}$ turns/m $\times \sqrt{tex}$	— —	— —	Yarns (as appropriate)
19.	Bursting strength	Newton per square centimetre	N/cm^2	Kilogram force per square centimetre	kgf/cm^2	Fabrics
20.	Tear strength	Millinewton Newton	mN N	grams force, kilogram force	gf, kgf	Fabrics (as appropriate)
21.	Pile height	Millimetre	mm	—	—	Carpets
22.	Pile density	Mass of pile yarn in grams per square metre per millimetre pile height	g/m^2/mm pile height	—	—	Pile carpet
23.	Elastic modulus	Millinewton per tex per unit deformation	mN/tex/ unit deformation	grams force per tex per unit deformation	gf/tex/ unit deformation	Fibres, yarns, strands

NOTE — Where more than one unit have been given for one characteristic, any of the units may be used appropriate.

RULES FOR ROUNDING OFF NUMERICAL VALUES

(Source : **IS 2 : 1960)**

To round off a value is to retain a certain number of figures, *counted from the left*, and drop the others so as to give a more rational form to the value. As the result of a test or of a calculation is generally rounded off for the purpose of reporting or for drafting specifications, it is necessary to prescribe rules for rounding off numerical values as also for deciding on 'the number of figures' to be retained.

1 SCOPE

1.1 This standard prescribes rules for rounding off numerical values for the purpose of reporting results of a test, an analysis, a measurement or a calculation, and thus assisting in drafting specifications. It also makes recommendations as to the number of figures that should be retained in course of computation.

2 TERMINOLOGY

2.0 For the purpose of this standard, the following definitions shall apply.

2.1 Number of Decimal Places

A value is said to have as many decimal places as there are number of figures in the value, counting from the first figure after the decimal point and ending with the last figure on the right.

Examples:

Value	*Decimal Places*
0.029 50	5
21.029 5	4
2 000.000 001	6
291.00	2
10.32×10^3 (*see* Note 1)	2

NOTE 1 — For the purpose of this standard, the expression 10.32×10^3 should be taken to consist of two parts, the value proper which is 10.32 and the unit of expression for the value, 10^3

2.2 Number of Significant Figures

A value is said to have as many significant figures as there are number of significant *digits* (*see* Note 2) in the value, counting from the left-most *non-zero* digit and ending with the right-most digit in the value.

Examples:

Value	*Significant figures*
0.029 500	5
0.029 5	3
10.029 5	6
2 000.000 001	10
5 677.0	5
567 700	6
56.77×10^2	4
0 056.770	5
3 900 (*see* Note 3)	4

NOTE 2 — Any of the digits 1, 2, 3, ...9 occurring in a value shall be a significant digit(s), and zero shall be a significant digit only when it is preceded by some other digit (excepting zeros) on its left. When appearing in the power of 10 to indicate the magnitude of the unit in the expression of a value, zero shall not be a significant digit

NOTE 3 — With a view to removing any ambiguity regarding the significance of the zeros at the end in a value like 3 900 it would be always desirable to write the value in the power-of-ten notation For example, 3 900 may be written as 3.9×10^3, 3.90×10^3 or 3.900×10^3 depending upon the last figure(s) in the value to which it is desired to impart significance

2.3 Fineness of Rounding

The unit to which a value is rounded off.

For example, a value may be rounded to the nearest 0.000 01, 0.000 2, 0.000 5, 0.001, 0.002 5, 0.005, 0.01, 0.07, 1, 2.5, 10, 20, 50, 100 or any other unit depending on the fineness desired.

3 RULES FOR ROUNDING

3.0 The rule usually followed in rounding off a value to unit fineness of rounding is to keep unchanged the last figure retained when the figure next beyond is less than 5 and to increase by 1 the last figure retained when the figure next beyond is more than 5 There is diversity of practice when the figure next beyond the last figure retained is 5. In such cases, some computers 'round up', that is, increase by 1, the last figure retained; others 'round down', that is, discard everything beyond the last figure retained. Obviously, if the retained value is always 'rounded up' or always 'rounded down', the sum and the average of a series of values so rounded will be larger or smaller than the corresponding sum or average of the unrounded values. However, if rounding off is carried out in accordance with the rules stated in **3.1** in one step (*see* **3.3**), the sum and the average of the rounded values would be more nearly correct than in the previous cases (*see* Annex A).

3.1 Rounding Off to Unit Fineness

In case the fineness of rounding is unity in the last place retained, the following rules shall be followed:

Rule I — When the figure next beyond the last figure or place to be retained is less than 5, the figure in the last place retained shall be left unchanged.

Rule II — When the figure next beyond the last figure or place to be retained is more than 5 or is 5 followed by any figures other than zeros, the figure in the last place retained shall be increased by 1.

> *Rule III* — When the figure next beyond the last figure or place to be retained is 5 alone or 5 followed by zeros only, the figure in the last place retained shall be (a) increased by 1 if it is odd and (b) left unchanged if even (zero would be regarded as an even number for this purpose).

Some examples illustrating the application of Rules I to III are given in Table 1.

a) If the remainder is less than $n/2$, the value shall be rounded down such that the rounded value is an integral multiple of n.

b) If the remainder is greater than $n/2$, the value shall be rounded up such that the rounded value is an integral multiple of n.

c) If the remainder is exactly equal to $n/2$, that rounded value shall be chosen which is an integral multiple of $2n$.

Table 1 Examples of Rounding Off Values to Unit Fineness

Value	Fineness of Rounding							
	1		0.1		0.01		0.001	
	Rounded Value	Rule	Rounded Value	Rule	Rounded Value	Rule	Rounded Value	Rule
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
7.260 4	7	I	7.3	II	7.26	I	7.260	I
14.725	15	II	14.7	I	14.72	III (b)	14.725	–
3.455	3	I	3.5	II	3.46	III (a)	3.455	–
13.545 001	14	II	13.5	I	13.55	II	13.545	I
8.725	9	II	8.7	I	8.72	III (b)	8.725	–
19.205	19	I	19.2	I	19.20	III (b)	19.205	–
0.549 9	1	II	0.5	I	0.55	II	0.550	II
0.650 1	1	II	0.7	II	0.65	I	0.650	I
0.049 50	0	I	0.0	I	0.05	II	0.050	III (a)

3.1.1 The rules for rounding laid down in 3.1 may be extended to apply when the fineness of rounding is 0.10, 10, 100, 1 000, etc. For example, 2.43 when rounded to fineness 0.10 becomes 2.40. Similarly, 712 and 715 when rounded to the fineness 10 become 710 and 720 respectively.

3.2 Rounding Off to Fineness Other Than Unity

In case the fineness of rounding is not unity, but, say, it is n, the given value shall be rounded off according to the following rule:

> *Rule IV* — When rounding to a fineness n, other than unity, the given value shall be divided by n. The quotient shall be rounded off to the nearest whole number in accordance with the rules laid down in 3.1 for unit fineness of rounding. The number so obtained, that is, the rounded quotient, shall then be multiplied by n to get the final rounded value.

Some examples illustrating the application of Rule IV are give in Table 2.

NOTE 4 — The rules for rounding off a value to any fineness of rounding, n, may also be stated in line with those for unit fineness of rounding (*see* 3.1) as follows:

Divide the given value by n so that an integral quotient and a remainder are obtained. Round off the value in the following manner:

Table 2 Examples of Rounding Off Values to Fineness Other Than Unit

(*Clause* 3.2)

Value	Fineness of Rounding, *n*	Quotient	Rounded Quotient	Final Rounded *Value*
(1)	(2)	(3) = (1)/(2)	(4)	(5) = (2) × (4)
1.647 8	0.2	8.239	8	1.6
2.70	0.2	13.5	14	2.8
2.496 8	0.3	8.3227	8	2.4
1.75	0.5	3.5	4	2.0
0.687 21	0.07	9.8173	10	0.70
0.875	0.07	12.5	12	0.84
325	50	6.5	6	3×10^2
1 025	50	20.5	20	10×10^2

3.2.1 Fineness of rounding other than 2 and 5 is seldom called for in practice. For these cases, the rules for rounding may be stated in simpler form as follows:

a) Rounding off to fineness 50, 5, 0.5, 0.05, 0.005, etc.

> *Rule V* — When rounding to 5 units, the given

value shall be doubled and rounded off to twice the required fineness of rounding in accordance with **3.1.1**. The value thus obtained shall be halved to get the final rounded value.

For example, in rounding off 975 to the nearest 50, 975 is doubled giving 1 950 which becomes 2 000 when rounded off to the nearest 100; when 2 000 is divided by 2, the resulting number 1 000 is the rounded value of 975.

(b) Rounding off to fineness 20, 2, 0.2, 0.02, 0.002, etc.

Rule VI — When rounding to 2 units, the given value shall be halved and rounded off to half the required fineness of rounding in accordance with **3.1**. The value thus obtained shall then be doubled to get the final rounded value.

For example, in rounding off 2.70 to the nearest 0.2, 2.70 is halved giving 1.35 which becomes 1.4 when rounded off to the nearest 0.1; when 1.4 is doubled, the resulting number 2.8 is the rounded value.

3.3 Successive Rounding

The final rounded value shall be obtained from the most precise value available in one step only and not from a series of successive roundings. For example, the value 0.549 9, when rounded to one significant figure, shall be written as 0.5 and not as 0.6 which is obtained as a result of successive roundings to 0.550, 0.55 and 0.6 . It is obvious that the most precise value available is nearer to 0.5 and not to 0.6 and that the error involved is less in the former case. Similarly, 0.650 1 shall be rounded off to 0.7 in one step and not successively to 0.650, 0.65 and 0.6, since the most precise value available here is nearer to 0.7 than to 0.6 (*see also* Table **1**).

NOTE 5 — In those cases where a final rounded value terminates with 5 and it is intended to use it in further computation, it may be helpful to use a '+' or '-' sign after the final 5 to indicate whether a subsequent rounding should be up or down. Thus 3.214 7 may be written as 3.215^- when rounded to a fineness of rounding 0.001. If further rounding to three significant figures is desired, this number would be rounded down and written as 3.21 which is in error by *less* than half a unit in the last place; otherwise, rounding of 3.215 would have yielded 3.22 which is in error by *more* than half a unit in the last place. Similarly, 3.205 4 could be written as 3.205^+ when rounded to 4 significant figures. Further rounding to 3 significant figures would yield the value as 3.21.

In case the final 5 is obtained exactly, it would be indicated by leaving the 5 as such without using '+' or '-' sign. In subsequent rounding the 5 would then be treated in accordance with Rule III.

4 NUMBER OF FIGURES TO BE RETAINED

4.0 Pertinent to the application of the rules for rounding off is the underlying decision as to the number of figures that should be retained in a given problem. The original values requiring to be rounded off may arise as a result of a test, an analysis or a measurement, in other words, experimental results, or they may arise from computations involving several steps.

4.1 Experimental Results

The number of figures to be retained in an experimental result, either for the purpose of reporting or for guiding the formulation of specifications will depend on the significance of the figures in the value. This aspect has been discussed in detail under **4** of IS 787: 1956 to which reference may be made for obtaining helpful guidance.

4.2 Computations

In computations involving values of different accuracies, the problem as to how many figures should be retained at various steps assumes a special significance as it would affect the accuracy of the final result. The rounding off error will, in fact, be injected into computation every time an arithmetical operation is performed. It is, therefore, necessary to carry out the computation in such a manner as would obtain accurate results consistent with the accuracy of the data in hand.

4.2.1 While it is not possible to prescribe details which may be followed in computations of various types, certain basic rules may be recommended for single arithmetical operations which, when followed, will save labour and at the same time enable accuracy of original data to be normally maintained in the final answers.

4.2.2 As a guide to the number of places or figures to be retained in the calculations involving arithmetical operations with rounded or approximate values, the following procedures are recommended:

a) *Addition* — The more accurate values shall be rounded off so as to retain *one more place* than the last significant figure in the least accurate value. The resulting sum shall then be rounded off to the last significant place in the least accurate value.

b) *Subtraction*—The more accurate value (of the two given values) shall be rounded off, before subtraction, to the *same place* as the last significant figure in less accurate value; and the result shall be reported as such (*see also* Note 6).

c) *Multiplication and Division*— The number of *significant figures* retained in the more accurate values shall be kept *one more* than that in the least accurate value. The result shall then be rounded off to the same number of significant figures as in the least accurate value.

d) When a long computation is carried out in several steps, the intermediate results shall be properly rounded at the end of each step so as to avoid the accumulation of rounding errors in such cases. It is recommended that, at the end of each step, one more significant figure may be retained than is required under (a), (b) and (c) (*see also* Note 7).

NOTE 6 — The loss of the significant figures in the subtraction two nearly equal values is the greatest source of inaccuracy in most computations, and it forms the weakest link in a chain computation where it occurs. Thus, if the values 0.169 52 and 0.168 71 are each correct to five significant figures, their difference 0.000 81, which has only two significant figures, is quite likely to introduce inaccuracy in subsequent computation.

If, however, the difference of two values is desired to be correct to *k* significant figures and if it is known beforehand that the first *m* significant figures at the left will disappear by subtraction, then the number of significant figures to be retained in each of the values shall be $m + k$ (*see* Example 4).

NOTE 7 — To ensure a greater degree of accuracy in the computations, it is also desirable to avoid or defer as long as possible certain approximation operations like that of the division or squareroot. For example, in the determination of sucrose by volumetric method, the expression $\frac{20w_1}{w_2}\left(\frac{f_2}{v_2} - \frac{f_1}{v_1}\right)$ may be better evaluated by taking its calculational form as $20w_1 (f_2v_1-f_1v_2)/w_2v_1v_2$ which would defer the division until the last operation of the calculation.

4.2.3 *Examples*

Example 1

Required to find the sum of the rounded off values 461.32, 381.6, 76.854 and 4.746 2.

Since the least accurate value 381.6 is known only to the first decimal place, all other values shall be rounded off to one more place, that is, to two decimal places and then added as shown below:

$$\begin{array}{r}
461.32 \\
381.6 \\
76.85 \\
4.75 \\
\hline
924.52
\end{array}$$

The resulting sum shall then be reported to the same decimal place as in the least accurate value, that is, as 924.5.

Example 2

Required to find the sum of the values 28 490, 894, 657.32, 39 500 and 76 939, assuming that the value 39 500 is known to the nearest hundred only.

Since one of the values is known only to the nearest hundred, the other values shall be rounded off to the nearest ten and then added as shown below:

$$\begin{array}{r}
2\,849 \times 10 \\
89 \times 10 \\
66 \times 10 \\
3\,950 \times 10 \\
7\,694 \times 10 \\
\hline
14\,648 \times 10
\end{array}$$

The sum shall then be reported to the nearest hundred as 1 465 × 100 or even as 1.465×10^5.

Example 3

Required to find the difference of 679.8 and 76.365, assuming that each number is known to its last figure but no farther.

Since one of the values is known to the first decimal place only, the other value shall also be rounded off to the first decimal place and then the difference shall be found.

$$\begin{array}{r}
679.8 \\
76.4 \\
\hline
603.4
\end{array}$$

The difference, 603.4, shall be reported as such.

Example 4

Required to evaluate $\sqrt{2.52} - \sqrt{2.49}$ correct to five significant figures.

Since $\sqrt{2.52} = 1.587\,450\,79$

$\sqrt{2.49} = 1.577\,973\,38$

and three significant figures at the left will disappear on subtraction, the number of significant figures retained in each value shall be 8 as shown below:

$$\begin{array}{r}
1.587\,450\,8 \\
1.577\,973\,4 \\
\hline
0.009\,477\,4
\end{array}$$

The result, 0.009 477 4, shall be reported as such (or as $9.477\,4 \times 10^{-3}$).

Example 5

Required to evaluate $35.2/\sqrt{2}$, given that the numerator is correct to its last figure.

Since the numerator here is correct to three significant figures, the denominator shall be taken as $\sqrt{2} = 1.414$. Then,

$$\frac{35.2}{1.414} = 24.89$$

and the result shall be reported as 24.9.

Example 6

Required to evaluate $3.78\pi/5.6$, assuming that the denominator is true to only two significant figures.

Since the denominator here is correct to two significant figures, each number in the numerator would be taken up to three significant figures. Thus,

$$\frac{3.78 \times 3.14}{5.7} = 2.08$$

The result shall, however, be reported as 2.1.

ANNEX A

(*Clause* 3.0)

VALIDITY OF RULES

A-1 The validity of the rules for rounding off numerical values, as given in **3.1**, may be seen from the fact that to every number that is to be 'rounded down' in accordance with Rule I, there corresponds a number that is to be 'rounded up' in accordance with Rule II. Thus, these two rules establish a balance between rounding 'down' and 'up' for all numbers other than those that fall exactly midway between two alternatives. In the latter case, since the figure to be dropped is exactly 5, Rule III, which specifies that the value should be rounded to its nearest even number, implies that rounding shall be 'up' when the preceding figures are 1, 3, 5, 7, 9 and 'down' when they are 0, 2, 4, 6, 8. Rule III hence advocates a similar balance between rounding 'up' and 'down' (*see also* Note 8). This implies that if the above rules are followed in a large group of values in which random distribution of figures occurs, the number 'rounded up' and the number 'rounded down' will be nearly equal. Therefore, the sum and the average of the rounded values will be more nearly correct than would be the case if all were rounded in the same direction, that is, either all 'up' or all 'down'

NOTE 8 — From purely logical considerations, a given value could have as well been rounded to an odd number (and not an even number as in Rule III) when the discarded figures fall exactly midway between two alternatives. But there is a practical aspect to the matter. The rounding off a value to an even number facilitates the division of the rounded value by 2 and the result of such division gives the correct rounding of half the original unrounded value. Besides, the (rounded) even values may generally be exactly divisible by many more numbers, even as well as odd, than are the (rounded) odd values.

SECTION B

TESTS FOR ROPES, CORDAGES AND NETS

TEST FOR PILOT LEAD LINE DETERMINATION OF CHANGE IN LENGTH

(*Source* : IS 3262 : 1987)

In order to avoid any excess expansion or contraction of pilot lead line which will affect its performance, this requirement has been laid down in IS 3262 : 1987. Keeping in view the need for determining the change of length of pilot lead line property and to achieve repeatability and reproductibility of test results, this test method has been prescribed.

---

1 SCOPE

This standard prescribes the method for determination of change in length of pilot lead line of 25 mm size.

2 PROCEDURE

2.1 From each test sample cut off a piece approximately 2 m in length. Mark the piece so that one can be identified with the other.

2.2 Take one piece and apply to it a tension equal to 2 percent of the breaking load, that is, 5 kg force.

NOTE – The tension can be applied by fixing one end of the piece to a peg, running the piece over a pulley and hanging a weight equal to 5 kg at the other end.

2.3 While the sample piece is under tension, place two gauge marks on it, exactly one metre apart.

2.4 Suspend the piece with 5-kg weight in a vessel full of water in such a way that the marked portion of the line remains well under water and the 5-kg weight tied to the lower end does not touch the bottom of the vessel (*see* Fig. 1). Keep the piece suspended in water for 48 hours. After this period take out the piece. Remove the 5-kg weight. Condition the piece to moisture equilibrium in standard atmosphere for 48 hours.

2.5 Take the piece and again apply a tension equal to 5-kg weight (*see* Note under 2.2). While the piece is under tension, measure the distance between the gauge marks.

3 CALCULATION

3.1 Calculate the percentage of change in length by the following formula:

$$C = \frac{l_1 - l}{l} \times 100$$

where

C = change in length in percent;

l_1 = length in mm, between the gauge, marks after suspension in water; and

l = length in mm, between the gauge marks before suspension in water.

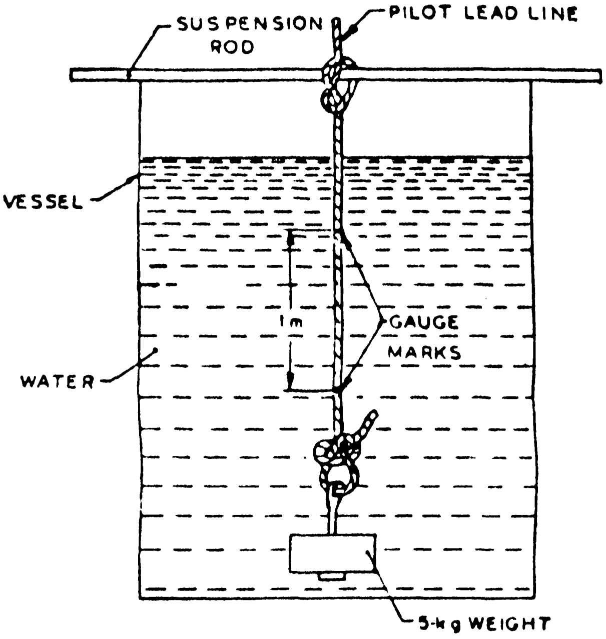


FIG. 1 METHOD OF SUSPENDING THE LINE FOR TESTING CHANGE IN LENGTH

3.2 Report the sample to be conforming in respect of change in length if the value obtained in 3.1 is not more than 0 7.

TESTS FOR ROPES AND CORDAGE DETERMINATION OF MASS, LENGTH AND LINEAR DENSITY

[*Source* : **IS 7071 (Part 2) : 1974**]

These test methods are based on methods in use for testing ropes and cordage in industry and trade. Considerable assistance has also been derived from ISO 2307-1972 'Ropes — Determination of certain physical and mechanical properties', issued by International Organization for Standardization and the existing Indian Standards on ropes and cordage.

---

1 SCOPE

1.1 This standard prescribes methods for determination of mass, linear density and length of ropes and cordage made from natural and man-made fibres.

2 APPARATUS

2.1 Balance

Capable of weighing to an accuracy of 1 g.

2.2 Measuring Tape

Calibrated in metres, centimetres and millimetres.

2.3 Tensioning Device

3 PROCEDURE

3.1 Without removing the wrapping material, weigh each coil in the lot to the nearest 1 percent and determine the total gross mass of all the coils in the lot (M_1).

3.2 Take the test sample and determine the gross mass without removing the wrapping material (M_2). Remove the wrapping material except the ties, from the coils and condition them to moisture equilibrium in a standard atmosphere. Weigh in grams each coil in the test sample and determine the net conditioned mass of all the coils in the test sample (M_3).

3.3 From one end of each of the coil in the test sample cut off a piece exactly 2 metre in length (l) after applying tension by hand. Mark the coil and the piece so that one can be identified with the other. Weigh the specimen in grams (m). Mark a length of 1 metre (d_1) in the centre of the specimen.

3.4 Take the piece and apply to it a tension as given in the material specification (*see* Notes 1 and 2). While the piece is under tension measure to the nearest millimetre the distance between the marks (d_2)

NOTES

1 Generally a tension of 2 percent (natural fibre ropes) and 0·6 percent (man-made fibre ropes) of the specified breaking load is applied.

2 The tension can best be applied in a breaking load testing machine, it can also be applied by fixing one end of the piece to a peg running the piece over a pulley and hanging the required weight at the other end. While drawing samples from the coils care shall be taken to see that it does not take up false twist, kinks, or other deformation.

3.5 Similarly perform the test with other test specimens.

4 CALCULATIONS

4.1 Linear Density

Calculate the linear density by the following formula:

$$T = \frac{m \times d_1}{l \times d_2}$$

where

T = linear density in kilotex (or g/m),

m = mass of the test piece in grams,

d_1 = distance between the marks (1 m),

l = length of the test specimen (2 m), and

d_2 = distance between the marks under tension in metres.

4.1.1 Similarly calculate the linear density of each coil under test.

4.2 Length of Coil

Calculate the length of coil by dividing the net mass of the coil (M_3) by the linear density of the corresponding coil as obtained in 4.1:

4.2.1 Similarly calculate the length in each coil under test.

4.3 Mass

If it is desired to determine the net conditioned mass of the lot in addition to the gross mass of the lot (*see* 3.1), calculate the same by the following formula:

$$M_C = \frac{M_3}{M_2} \times M_1$$

where

M_C = conditioned mass of the lot,

M_1 = gross mass of the lot (*see* 3.1),

M_2 = gross mass of the coils in the test sample (*see* 3.2), and

M_3 = conditioned net mass of the coils in the test sample (*see* 3.2).

5 REPORT

5.1 The report shall include the following information:

a) Type of material,
b) Atmospheric conditions,
c) Gross mass of lot,
d) Net mass of lot (if required),
e) Linear density,
f) Length of each coil, and
g) Number of tests.

TESTS FOR ROPES AND CORDAGE DETERMINATION OF DIAMETER, CIRCUMFERENCE AND LAY

[*Source* : IS 7071 (Part 3) : 1974]

These test methods are based on methods in use for testing ropes and cordage in the industry and trade. Considerable assistance has been derived from ISO 2307-1972 'Ropes – Determination of certain physical and mechanical properties' issued by International Organisation for Standardisation, and the existing Indian Standards on ropes and cordage.

---

1 SCOPE

1.1 This standard prescribes methods for determination of diameter, circumference and lay of ropes and cordage made from natural and man-made fibres.

2 APPARATUS

2.1 Rope Gauge or a Pair of Calipers

2.2 Tensioning Device

2.3 Measuring Tape

3 PROCEDURE

3.1 Condition all the coils in the test sample to moisture equilibrium in the atmosphere for testing after removing the wrapping material except the ties.

3.2 From one end of each of the coils in the test sample, cut off a piece of at least 2 m length. Mark the coil and the piece, so that one can be identified with the another.

3.3 Take one piece and apply to it a tension as given in material specification (*see* Notes 1 and 2).

NOTES

1 Generally a tension equal to 2 percent (in case of natural fibre ropes) and 0.6 percent (in case of man-made fibre ropes) of the specified breaking load is applied.

2 The tension can best be applied in the breaking load testing machine, it can also be applied by fixing one end of the piece to the peg, running the piece over a pulley and hanging the required weight at the other end. While drawing samples from the coils care shall be taken so that it does not take up false twist, kinks, or other deformations.

3.4 Diameter

While the piece is under tension, measure its diameter to the nearest millimetre by means of a rope gauge or a pair of calipers of suitable size (or other suitable means) taking care to ensure that the jaws rest on the outside of the strands.

NOTE – Measurement of diameter is not valid in case of 8-strand plated ropes.

3.5 Circumference

While the piece is still under tension, measure its circumference to the nearest millimetre by means of a rope gauge or other suitable means.

3.6 Lay

While the piece is still under tension, measure the length (*l*) in millimetre of 10 complete turns of the same strand (*see* Fig. 1) or in the case of plaited rope, the length between 10 successive points of plaiting (*see* Fig. 2).

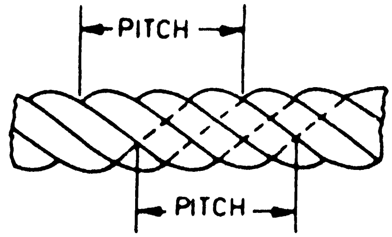


FIG. 1 LAY OR PITCH OF ROPE

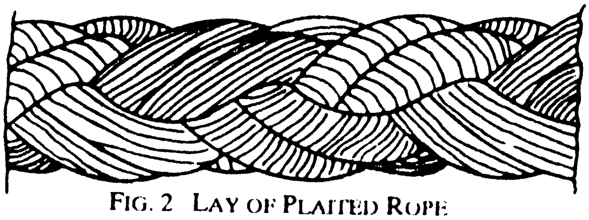


FIG. 2 LAY OF PLAITED ROPE

3.7 Turns per Unit Length

If required, calculate the turns per unit length of the rope by counting the turns in one metre, while the piece is still under tension.

3.8 Similarly, determine the diameter, circumference, lay and turns per unit length if required of the remaining coils of the test sample.

4 CALCULATIONS

4.1 Calculate the average values for the diameter, circumference, lay and turns per metre of all the observations made.

5 REPORT

5.1 Report shall include the following information:

a) Type of material,

b) Atmospheric conditions for testing,

c) Diameter in millimetre,

d) Circumference in millimetre,

e) Length of lay in millimetre,

f) Turns/metre, and

g) Number of tests.

TESTS FOR ROPES AND CORDAGE
DETERMINATION OF BREAKING LOAD AND ELONGATION AT BREAK

[*Source* : **IS 7071 (Part 4) : 1986**]

In the preparation of this test method, due weightage has been given to the testing practices followed in the industry and trade in this field. Considerable assistance has also been derived from ISO 2307-1972 'Ropes — Determination of certain physical and mechanical properties' and BS 5053 : 1985 'Methods of test for cordage and webbing slings and fibre cores for wire ropes', issued by International Organization for Standardization and the British Standards Institution, respectively.

---

1 SCOPE

1.1 This standard prescribes methods of test for determination of breaking load and elongation at break of ropes and cordage made from natural and man-made fibres.

2 PRINCIPLE

2.1 The specimen is gripped between two clamps of a tensile testing machine and continually increasing load is applied by moving one of the clamps until the specimen ruptures. Values of breaking strength and elongation of the test specimen are read directly or from a chart attached. In case of ropes having very high breaking strength, the yarns taken from rope are tested and then strength of rope is calculated from these.

3 APPARATUS

3.1 Testing Machine

A constant rate traverse type tensile testing machine of appropriate capacity. The load range of the machine shall be such that the observed values would be between 10 and 90 percent of the full scale load. The permissible error in the machine at any point in this range shall not exceed ± 1 percent. The machine shall be provided with the following arrangements:

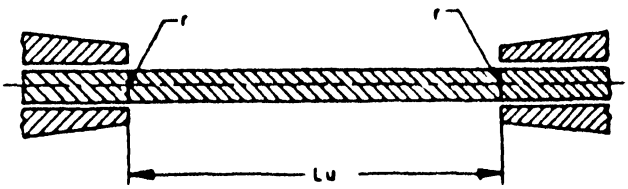
a) Clamps for holding the specimen which may be any of the following types:
   1) Ordinary or wedge grips (*see* Fig. 1),
   2) Bollard grips for use with eye spliced test specimens (*see* Fig. 2),
   3) Pulleys commonly called 'Cor-de-chasse' grips (*see* Fig. 3), and
   4) Ram horn grips (*see* Fig. 4).

b) Each clamp shall be provided with a mechanical or pneumatic device so constructed that through its means a specimen can be secured firmly between the jaws of the clamps so that it does not slip during the test. Also the edge of the surface of each clamp shall be such that it would not cut or damage the specimen during testing.

c) Means for applying pre-tension of 2 percent breaking load to the specimen when clamped (the tension device may be deadweight, a spring or an air-actuated mechanism).

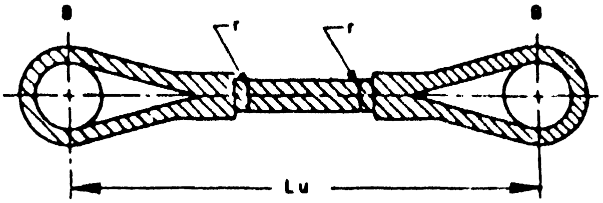
d) Means for adjusting the distance between the clamps.

e) A scale or dial or autograph recording chart graduated so as to give load in kilograms and elongation in millimetres.



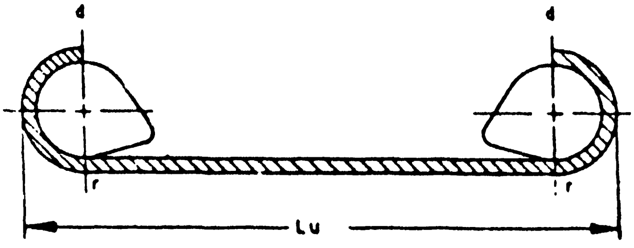
The limiting marks 'r' on the test piece shall be positioned in line with the grips

FIG. 1 TEST PIECE MOUNTED BETWEEN WEDGE GRIPS



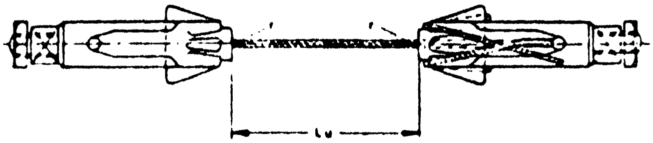
The limiting marks 'r' shall be 150 mm from the last turn of the splice.

FIG. 2 EYE SPLICED TEST PIECE BETWEEN TWO BOLLARDS



The limiting marks 'r' shall be positioned where the rope leaves the Cor-de-chasse.

FIG. 3 TEST PIECE MOUNTED ON PULLEYS (COR-DE-CHASSE)



The limiting marks 'r' on the test piece shall be positioned in line with the grips.

FIG. 4 TEST PIECE MOUNTED BETWEEN RAM HORN GRIPS

3.2 Measuring Tape

4 MOUNTING OF TEST SPECIMENS

4.1 Fix the ends of the test piece between the wedge grips on the pulleys or on the bollards, or by its eye splices on the bollards or between 'Ram horn Grips' according to the type of grips used (*see* Fig.1, 2, 3, and 4) in such a way as to obtain the effective test length, *Lu*, of test specimen specified in Table 1.

Table 1 Effective Test Lengths

Rope Dia	Test Length
Greater than 10 mm	1 m
10 mm and less	250 mm

4.1.1 The effective test length, *Lu*, shall be measured under zero tension, the test specimen being simply held straight for each of the four principal types of grips.

4.1.2 The separation of strands by untwisting or unplaiting the ends of the test piece when the testing is carried out as indicated by Fig. 1 and 3, shall not be done before testing.

4.1.3 In the case of pulleys, ropes of diameter above 12 mm can be untwisted or unplaited beyond point *d* on the circumference of the pulleys for the purpose of fixing the ends (*see* Fig. 3).

NOTE — It is recommended as far as possible wedge grips should not be used as rope is likely to slip or fibres getting damaged during testing resulting in erroneous results. However, if these grips are used, enough care should be taken to see that the slippage or the damage does not occur.

4.1.4 In case of eye splicing, the eyes shall have an internal length between 250 and 300 mm when measured closed and splices shall be made to the manufacturers discretion. In the case of man-made fibre ropes, it is recommended that the end of the splices be tapered to finish.

4.1.5 The bollard diameter (*b*) shall be at least 100 mm for ropes of a nominal diameter of 40 mm or less, and 150 mm for ropes with a nominal diameter above 40 mm.

4.2 With the test piece mounted on the testing machine apply the marks *r* limiting the portion of the test piece within which the rope is normally expected to break during the course of the breaking test.

4.3 The rate of traverse of the straining head of the testing machine shall be constant. The applicable rates of traverse shall be as given below:

Man-Made Fibre Ropes	*Natural Fibre Ropes*
Within 75-250 mm/min	Within 150-305 mm/min

5 PROCEDURE

5.0 Condition the test specimen as per the procedure.

5.1 Method A – by Rope Test

5.1.1 Take the conditioned test specimen and mount it on the machine as given in 4 depending upon the type of rope and the type of clamps used. Set the machine to the required rate of traverse (*see* 4.3). Start the machine and carry the test to rupture.

5.1.2 Record the breaking load and elongation at break of the specimen. Observe the location of the break, on the test piece on completion of the test in order to establish whether or not the test results represent the true strength of the rope (*see* Note). Damage to the test piece caused by the holding devices seriously affect the test results. The breakage should occur between two marks put on the test piece (*see* 4.2).

NOTE – In case of eye spliced test, the ropes shall be deemed to conform to the requirements of the specification provided that the breaking load for the specimen is a minimum of 90 percent of the specified breaking load when the rupture occurs beyond *r* (*see* Fig. 2)

5.1.3 If the breakage takes place beyond the marks and below the specified breaking strength the test piece shall be considered to be conforming to the tensile strength requirement of the specification if the load recorded is not less than 90 percent of the specified breaking strength. If not, the test shall be discarded and new test carried out.

5.1.4 Similarly test the other test specimens.

5.1.5 *Calculations*

Calculate the average breaking strength and elongation at break of all the observations made.

5.2 Method B – by Rope Yarn Test

5.2.1 The breaking load of rope is calculated from average breaking load of the single rope yarn in this method by unstranding sufficient length of rope in order to obtain rope yarns required for testing.

5.2.2 For calculating breaking load, realization factors have been provided in Table 2. For this method conditions given below shall be applicable:

a) Where the rope is made from one size, type and construction of rope yarn, test at least 15 rope yarns, of which 3 in every 15 are selected from the centre of the strands.

b) For ropes made from more than one size, type and construction of yarn, test at least 15 rope yarns, but find out first the number of each size, type and construction of the rope yarn.

Select a proportionate number of each size and type for test.

c) Ensure that selected rope yarns are long enough to provide a minimum length of 250 mm between the grips of the testing machine.

5.2.3 Mount each rope yarn in turn in the testing machine and observe the breaking load. Ensure that the twist in yarn is not disturbed prior to test.

5.2.4 *Calculations*

Find out the average of all the observed results and calculate from these the breaking load of the rope in accordance with the following formula:

a) When the rope is made from one size, type and construction of yarns

$$BL = y \times n \times r$$

where

BL = calculated breaking load, in kg;

y = average strength of the yarns, in kg;

n = umber of yarns in the rope; and

r = realization factor as given in Table 2

b) When ropes are made from more than one size, type and construction of rope yarns.

$$BL = y \times r$$

where

BL = calculated breaking load, in kg;

y = aggregate strength of rope yarns in the rope (this aggregate is obtained by adding together the overall strength of each size, type of construction of yarn multiplied by the number of such yarns in the rope).

r = realization factor as given in Table 2.

Table 2 Realization Factors

(*Clauses* 5.2.2 *and* 5.2.4)

Nominal Diameter or Reference Number mm	Realization Factor for							
	Manila and Sisal Ropes			Synthetic Fibre Ropes				
	3-Strand	4-Strand	9-Strand	3 or 8-Strand polyamide	3-Strand polyester	3-Strand Polyethylene	3 or 8-Strand polypropylene fibrillated film*	3 or 8-Strand polypropylene monofilament or staple fibre
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
24	-	-	-	0.750 0	0.622 2	0.786	-	-
28	-	-	-	0.737 6	0.604 2	0.765	-	-
32	-	-	-	0.727 0	0.592 5	0.752	-	-
36	-	-	-	0.717 7	0.584 0	0.741	-	-
40	-	-	-	0.709 5	0.576 8	0.731	0.890	0.871 9
44	-	-	-	0.702 2	0.570 5	0.723	0.880	0.864 6
48	0.608	0.547	0.511	0.695 8	0.565 5	0.715	0.875	0.858 3
52	0.602	0.541	0.502	0.690 0	0.561 0	0.708	0.870	0.853 1
56	0.597	0.537	0.494	0.685 0	0.557 2	0.702	0.865	0.848 3
60	0.592	0.533	0.487	0.680 8	0.553 6	0.697	-	-
64	0.589	0.530	0.480	0.677 0	0.550 2	0.692	0.855	0.839 5
68	0.585	0.527	-	-	-		-	-
72	0.582	0.524	0.469	0.670 0	0.544 6	0.684	0.845	0.833 2
76	0.579	0.521	-	-	-	-	0.840	0.828 6
80	0.577	0.519	0.461	0.665 0	0.540 0	-	0.835	0.824 2
88	0.574	0.517	0.456	0.661 3	0.536 7	-		
96	0.572	0.515	0.452	0.657 8	0.533 3	-		
104	0.570	0.513	0.433					
112	0.568	0.511	0.431					
120	0.567	0.509	0.429					
128	0.566	0.507	0.428					
136	0.564	0.505	0.426					
144	0.563	0.503	0.424					

* These values are only applicable when the fibrillated film rope yarns have an elongation at break of at least 7 percent. The method should not be used when the elongation value is less

6 REPORT

6.1 The report shall include the following information:

a) Type of material,

b) Method used,

c) Type of grips used,

d) Number of test specimens tested,

e) Test length,

f) Breaking load, and

g) Elongation.

6.2 If the breaking strength has been calculated, mention shall be made of this fact in the test report, in commercial documents, and in dealings with the purchaser.

TEST FOR INDUSTRIAL SAFETY NETS DETERMINATION OF DROP TEST

(*Source* : IS 11057 : 1984)

Industrial safety nets are designed to catch personnel and/or debris falling whilst work on high buildings, and structural work of ship building is being carried out. In order to ensure the safety aspect of such nets a need was felt for evolving a performance test for such nets and accordingly this test method has been prescribed.

1 SCOPE

1.1 This standard prescribes the method for determination of drop test of industrial safety nets.

2 METHOD OF TEST

2.1 General

If an overlay net is provided for use with the safety net, testing shall be carried out on the safety net without the overlay net.

3 SELECTION OF SAMPLE FOR TEST

3.1 At least one sample of each type or construction of net shall be subjected to this loading test.

4 APPARATUS

4.1 Supporting framework, rigid and strong enough to resist shock load imposed during the test without serious distortion or deflection. A suitably supporting framework is illustrated diagramatically in Fig. 1.

4.2 Test mass, consisting of a bag of sand of mass 140 kg. The bottom shall be hemispherical with a radius of 20 cm (1 260 cm^2 cross-section).

5 PROCEDURE FOR THE DROP TEST

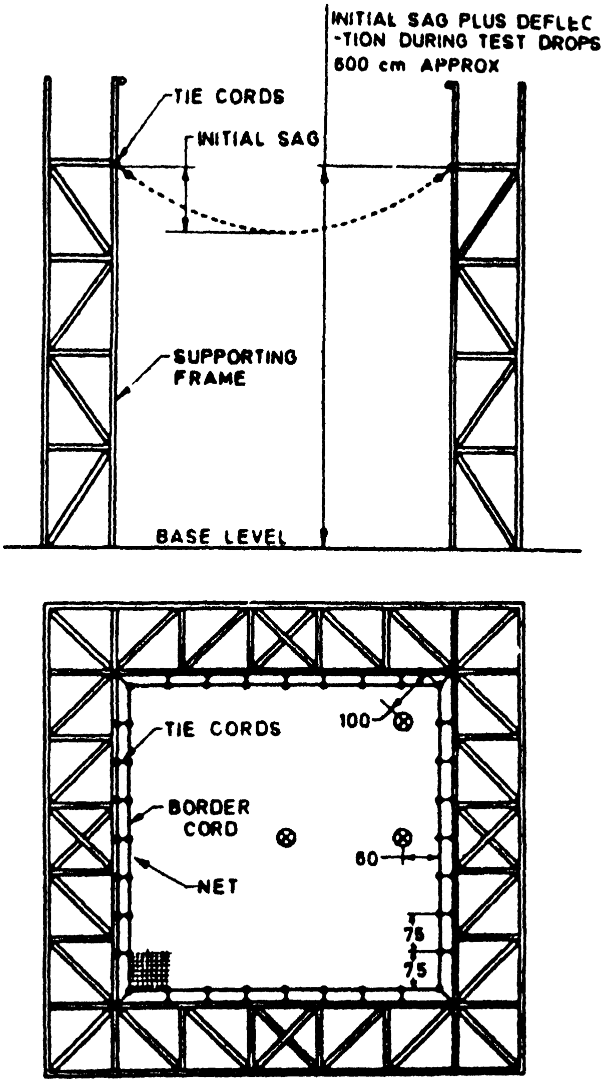
5.1 Suspend the net on a rigid framework as shown in Fig. 1 and conduct the test by dropping the test mass successively three times on to the centre of the net, then once on to a point on a diagonal 100 cm from one corner of the net and once half-way along any side 60 cm from the border cord of the net (*see* Fig. 1).

The test drop height for nets of each type shall be:

a) for nets of maximum duty height of 6 m : a 12 m test drop height; and

b) for nets of maximum duty height of 1 m : a 3 m test drop height.

The deflection of the net for each of the three drops at the centre shall be measured and the mean deflection, in metres, calculated.



All dimensions are in Centimetres.

NOTE — Dropping points for test loads are shown at ⊗

FIG. 1 TEST RIG FOR INDUSTRIAL SAFETY NETS

TESTS FOR CARGO HANDLING NETS
DETERMINATION OF DIMENSION AND PROOF LOAD OF NET

(*Source* : IS 11521 : 1985)

1 SCOPE

1.1 This standard prescribes method for determination of dimensions and proof load of cargo handling nets made from polyamide and polypropylene ropes and designed to lift material from and into ships, etc.

2 DIMENSIONS

2.1 The specimen cargo nets shall be unfolded and spread on the floor. Initial tension shall be applied by pulling on the hands and then the net shall be allowed to relax on the floor for 3 minutes.

2.2 The length and width of the net shall be measured from centre to centre of the border cords. The length of the hands shall be measured from one end of its eye to the other end (as shown in Fig. 1).

2.3 Three meshes shall be measured per net, of which at least one shall be near the centre of the net and at least one shall be at the edge of the net. The distance between two sequential knots or joints in the vertical and in the horizontal side measured from centre to centre shall give the two dimensions of the mesh.

3 PROOF LOAD

3.1 The specimen of cargo net is spread out on the floor. Gunny sacks containing sand and each weighing between 30 and 50 kg are spread uniformly over the mesh cords until a total mass which is 25 percent in excess of the safe working load is reached. The specimen net is then lifted by means of its hands off the floor up to a distance of at least 500 mm.

3.2 The net remains suspended for five minutes and is then lowered on the floor and the load removed. This net is then visually examined to check whether any fractures or splice slippages have taken place in the mesh cords, border cords and hands.

3.3 A specimen net which has been proof loaded as above and has, after this test, no fractures or splice slippages is deemed to have a safe working load as specified.

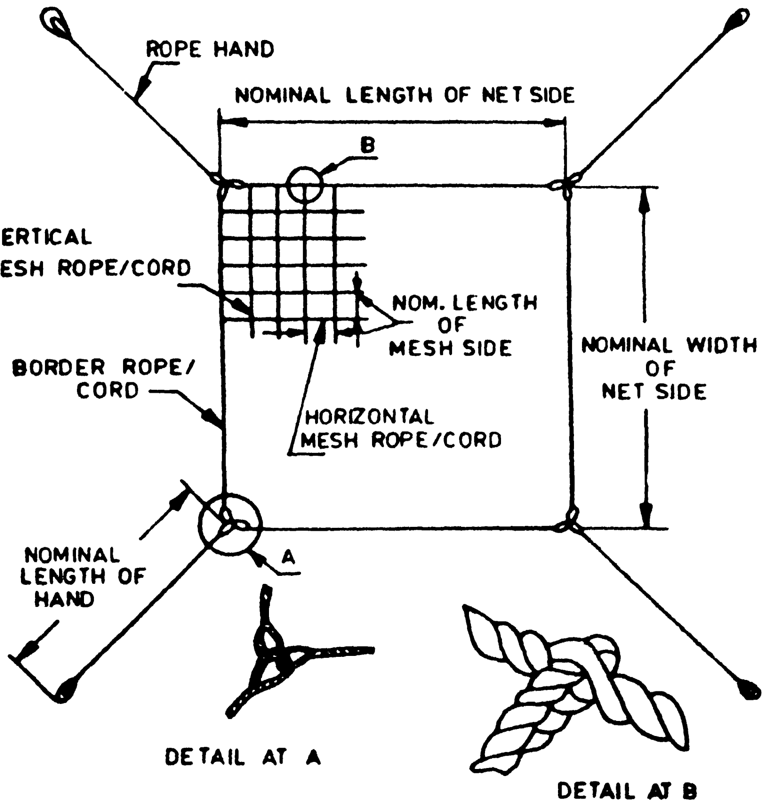


FIG. 1 CARGO HANDLING NET

SECTION C

TESTS FOR COIR PRODUCTS

TESTS FOR RUBBERIZED COIR SHEETS FOR CUSHIONING DETERMINATION OF LENGTH AND WIDTH, THICKNESS, INDENTATION HARDNESS, RESISTANCE TO AGEING, COMPRESSION SET, *p*H VALUE, CHLORIDE CONTENT AND DENSITY

(*Source* : IS 8391 : 1987)

1 SCOPE

1.1 This standard prescribes the methods of tests for determination of length and width, thickness, indentation hardness, resistance to ageing, compression set, *p*H value, chloride content and density of rubberized coir sheets for cushioning.

2 PREPARATION AND CONDITIONING OF SAMPLES

2.1 Preparation

2.1.1 Wherever practicable, the tests shall be conducted on the whole rubberized coir sheet.

2.1.2 The specimen shall be cut from the centre of the sample piece as far as possible and the specimen shall be subjected to test, preferably within 24 hours of cutting.

2.1.3 When the finished product does not lend itself to testing or to the preparation of test pieces because of complicated shape, small size or other reasons, standard test slabs shall be prepared.

2.1.4 When difference due to the difficulty in obtaining suitable test pieces from the finished product arise, the manufacturer and the purchaser may agree on acceptable deviations. This can be done by comparing results of standard test pieces and those obtained on actual product.

2.1.5 Test shall be carried out not before 48 hours after vulcanization of the sample. Samples and test pieces shall be protected from light as completely as possible and from any stress or strain whenever they are not actually in the process of being tested.

2.2 Conditioning

Each sample selected for test shall be conditioned for a minimum period of 24 hours at 27±2°C and 65±5 percent relative humidity prior to testing and testing shall be in the same atmosphere; when the testing cannot be carried out in the same atmosphere then the testing shall be commenced within two minutes of withdrawal of specimen from the conditioning atmosphere.

3 METHOD OF TEST FOR MEASUREMENT OF DIMENSIONS

3.1 Determination of Length and Width

Measure the length and width of the sample using a steel rule nearest to 1 mm, ensuring the measurement along a line perpendicular to opposing faces of the sample.

4 DETERMINATION OF THICKNESS

4.1 A test specimen 100 × 100 mm cut out from the sample shall be placed between two larger horizontal plates with a load of 200 g on its upper surface. The distance between the plates is determined at about the middle on each side correct to the nearest millimetre and the average of the four readings taken as the thickness of the sample.

4.2 Determination of Thickness of the Whole Sample

The instrument for measuring the thickness consists of a 250 mm long, rigid, narrow measuring needle made out of the suitable material and finished to give a smooth polished surface, one end of which is fixed vertically to the centre of a polished plate of 3 mm thickness and 50 × 50 mm size, the other end being tapered to a point, to facilitate insertion of the rod through the rubberized coir sheet. The needle is calibrated in millimetre all along its length starting with the point fixing it with the plate as 0, every 5 and 10 mm from this point being prominently marked out. A disc of 35 mm diameter, weighing 200 g with a central hole to facilitate movement of the weight all along the length of the calibrated needle also forms part of the measuring instrument.

4.3 Procedure

For measuring the thickness of the sample, the calibrated needle measuring instrument is inserted through the bottom side of the rubberized coir sheets, so that the needle is in a plane perpendicular to the free surface of the rubberized coir sheets and the base plate of the instrument is in contact with the bottom side of the rubberized coir sheets. Thereupon, the sliding weight is introduced on the projecting part of the needle and the combined thickness of the rubberized coir sheets and that of the sliding weight read directly, correct to the nearest 1 mm, on the calibrated needle. The thickness of the sliding weight is deducted from this reading to obtain the thickness of the test sample. The measurements are recorded at last at four points at random on the test piece and the average value taken as the thickness of the test material.

5 METHOD FOR DETERMINATION OF INDENTATION HARDNESS INDEX

5.1 Test Specimen

Cut out a test specimen measuring 100 × 100 mm, leaving a space of 25 mm from the edges of the whole piece.

5.2 Apparatus

5.2.1 The testing apparatus shall be capable of applying an indentor in such a way that the load is applied on the sample at a uniform rate and shall have a dial scale platform balance of suitable capacity for measuring the load required to produce the specified indentation. The sample shall be placed on the smooth flat horizontal surface of the platform of the dial scale balance, the surface of the platform being larger than the size of the sample.

5.2.2 The essential parts of the testing apparatus (*see* Fig. 1) are an adjustable indentor of the dimension specified in **5.2.2.1**, which can be moved vertically up or down by a threaded shaft, working through a sleeve of same pitch and dimension, operated by a hand wheel. The sleeve is fitted to a framework which rests on the horizontal surface of a table without having contact with the platform of a dial scale balance of 20 kg capacity graduated in 50 g sub-division. The thickness of the sample can be measured by means of a pointer mounted on the indentor with suitable guides and sliding in front of a vertical scale graduated in millimetres. The pointer is so adjusted that when the indentor touches the platform of the balance, the reading of the pointer on the scale is zero.

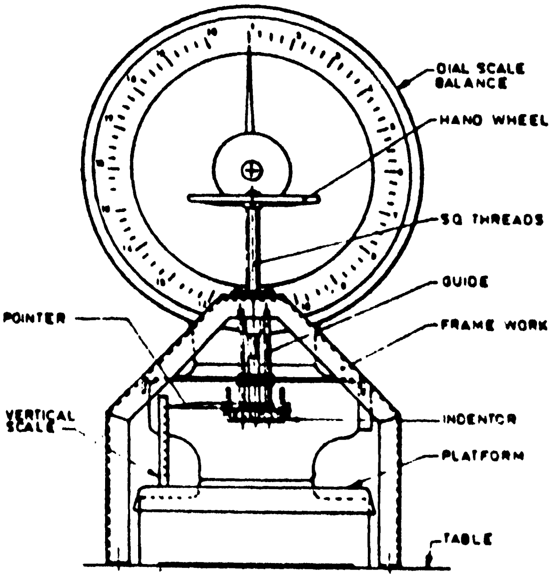


FIG. 1 APPARATUS FOR INDENTATION TEST

5.2.1.1 *Indentor*

A 105-mm square mild steel plate of 3 mm thickness shall constitute the indentor, fitted to the threaded shaft by a ball and socket joint, so that the surface of the indentor can adjust itself to the contour of the test specimen.

5.3 Procedure

5.3.1 The test specimen shall be size minimum 100 × 100 mm. Raise the indentor to a height greater than the thickness of the sample and place the sample over the platform of the balance below the indentor. Note the weight of the sample recorded by reading on the dial scale of the balance (x g). Lower the indentor by rotating the handle so as to press the sample against the platform of the balance. When the balance reads (200 g + xg), note the reading of the pointer on the scale to record the thickness of the sample (t_1). Gradually lower the indentor to apply a load at the rate of 0.5 kg/mm until the sample is pressed to a thickness of 60 percent of t_1. The load recorded on the dial scale for this indentation is taken as the Indentation Hardness Index of the specimen.

6 METHOD FOR DETERMINATION OF RESISTANCE TO AGEING

6.1 Principle

6.1.1 The ageing test consists of subjecting samples to controlled deterioration by air at elevated temperature and atmospheric pressure after which the physical properties are measured and compared with those of unaged samples. The deterioration is measured by the observed change in indentation hardness index.

6.2 Test Specimen

6.2.1 From each sample cut out two test specimens of size 100 × 100 mm and mark the specimens as 1 and 2. Take one of the specimen for ageing test and the other specimen shall be used for comparing with the aged specimen.

6.3 Procedure

6.3.1 Arrange for an air oven of such size that the total volume of test specimens does not exceed 10 percent of the free space in the oven. Make provision for suspending specimens so that they are not within 12 mm of each other or the oven sides. Control the temperature of the oven thermostatically so that the test specimens are kept at 70 ± 2°C. Place thermometer near the centre of the oven to record the actual ageing temperature.

6.3.2 Adjust the oven to 70 ± 2°C. Place the test specimens in the oven adjusted as indicated in **6.3.1**. Arrange the test specimens so that they are stationary, free from strain, freely exposed to air on all sides and not exposed to light. Continue the ageing for 48 hours. At the completion of the ageing period, remove the test specimens from the oven and place on a flat surface to cool to room temperature. Allow them to cool for not less than 24 hours. Measure the indentation hardness index of the aged specimens as in **5**.

6.3.3 Test the unaged test specimen also for indentation hardness requirements within 24 hours period of commencing of the ageing of the other sample.

6.3.4 Compare the indentation hardness index of both aged and unaged test specimens.

7 METHOD FOR DETERMINATION OF RESISTANCE TO FLEXING

7.1 Method

7.1.1 The method involves subjecting a sample to continued flexing with an indentor for 250 000 cycles at 4 cycles/sec and measuring the loss in indentation hardness.

7.2 Test Specimen

7.2.1 Cut out a test specimen measuring 100 × 100 mm, leaving 25 mm from the edges of the whole piece.

7.3 Apparatus

7.3.1 The essential parts of the apparatus (*see* Fig. 2), which has been found suitable, consists of an indentor of dimensions specified in 7.3.2, connected through a threaded adaptor and held by a locking nut to a push rod. This push rod is constrained to move vertically by fixed sleeves and is driven vertically by a motor which rotates a crank disc, the crank disc and push rod being joined by a connecting rod. This connecting rod is adjustably mounted in a radial slit in the crank disc, the length of the strokes, therefore, being adjustable. The motor is mounted upon a steel beam above the table upon which the specimen to be tested is placed.

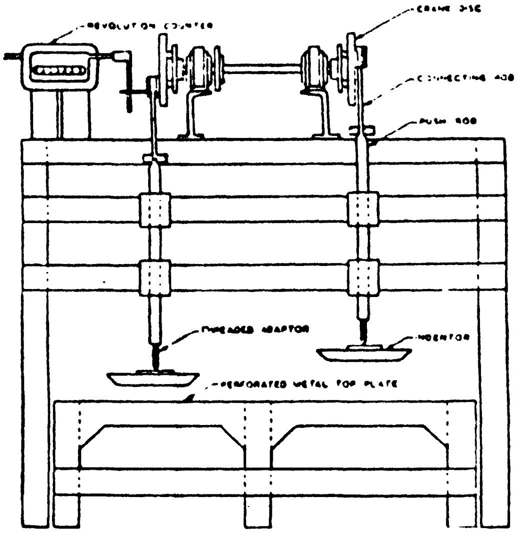


FIG. 2 APPARATUS FOR FLEXING TEST

A square frame made of mild steel angles with a clear internal dimension of 107 × 107 mm is positioned on the table just below the indentor to prevent lateral movement of the specimen in the course of its repeated flexing by the indentor. The fixtures are adjusted for effecting four flexes per second. A revolution counter is attached to the machine to record the number of flexes for the specimen.

7.3.2 A 105-mm square mild steel plate of 3 mm thickness shall constitute the indentor.

7.4 Procedure

7.4.1 Measure the thickness of the sample as described in 4. Determine the indentation hardness index as given in 5. Adjust the stroke of the crankshaft for a depression of the indentor by a distance equal to 40 percent of the thickness of the sample. This is done by adjusting the position of the connecting rod in the crank disc. Raise the indentor to the topmost position of the stroke and place the test specimen in the mild steel angle box below the indentor. Place wooden blocks of suitable thickness below the specimen to ensure that the top surface of the specimen is in contact with the bottom side of the indentor when the indentor is at the topmost position of the stroke. Subject the specimen to flexing at a rate of 4 flexes per second. After flexing 250 000 cycles, allow the sample to remain for 30 minutes. Thereafter, determine the indentation hardness index by test described in 5. The variation in the indentation hardness index is calculated as percentage of the initial hardness index.

8 METHOD FOR DETERMINATION OF COMPRESSION SET

8.1 Principle

8.1.1 The compression set under constant deflection is the measure of the residual strain in a test piece after it has been strained under compression to a given extent for a given time and then allowed to recover for a given time, the temperature being substantially constant during the test.

8.2 Test Specimen

8.2.1 The test piece shall be of size 100 × 100 mm.

8.3 Apparatus

8.3.1 The compression device shall consist of two flat steel plates, between the parallel faces of which the test piece is compressed. Steel spacers in the form of bars and of thickness such as to give the required 40 percent compression shall be provided to control the thickness of the piece during the test.

8.4 Procedure

8.4.1 Measure accurately the initial thickness of the test piece as in 2.2. Compress the test piece by 40 percent of its original thickness between the parallel steel plates, which shall be larger than the test piece. Use steel spacers between the plates, sufficient clearance being allowed for tilting of the test piece and care being taken to avoid displacement of the test piece. After being compressed for 22 hours at a temperature of 70 ± 2°C, remove the test piece from the clamp while still at the test temperature and allow to recover for 3 hours at room temperature. Then measure the thickness of the test piece again. Test at least two test pieces and take the average of test results.

Calculation — Calculate the compression set as follows:

Compression set at constant strain, percent

$$= \frac{T_0 - T_r}{T_0} \times 100$$

where

T_0 = original thickness of the test piece, and

T_r = thickness of the test piece after recovery.

9 METHOD FOR DETERMINATION OF *p*H VALUE AND CHLORIDE CONTENT

9.1 Test Specimens

9.1.1 Draw a square piece of rubberized coir sheet weighing about 10 g.

9.2 Preparation of Aqueous Extract

9.2.1 Cut the piece taken into about 5 mm square pieces and weigh. Transfer to a clean, chemically resistant glass flask, fitted with ground glass joint for reflux condenser. Add distilled water weighing 20 times the weight of the rubberized coir under test, to the flask. Fit the flask to the reflux condenser and heat the contents of the flask to boil. Continue boiling for 1 hour. Remove the flask and close while the liquid is still boiling gently using a clean ground glass stopper. Cool to room temperature.

9.3 Determination of *p*H Value

9.3.1 Transfer a portion of the aqueous extract to the electrode of *p*H meter and determine the *p*H.

9.4 Determination of Chloride Content

9.4.1 *Principle*

Chlorides are determined volumetrically by titration with standard silver nitrate solution.

9.4.2 *Reagents*

Calcium carbonate (*chloride free*)

Standard silver nitrate solution — 0.1 N.

Potassium chromate solution — Five percent (Dissolve 50 g of potassium chromate in distilled water. Add silver nitrate solution till a definite red precipitate is formed. Allow it to stand for overnight and filter. Dilute the filtrate to 1 litre with distilled water).

9.4.3 *Procedure*

Take a portion of the aqueous extract as prepared in 9.2. Neutralize with calcium carbonate till a pale yellow colour is obtained (usually 0.5 g is sufficient). Add 1 ml of potassium chromate indicator solution and titrate with standard silver nitrate solution till a red colour is obtained.

9.4.4 *Calculation*

Chloride (as Cl), percent by mass

$$= \frac{3.546\,(V_1 - V_2)\,N}{W}$$

where

V_1 = volume in ml of standard silver nitrate solution used in the titration with the material,

V_2 = volume in ml of standard silver nitrate solution used in the blank determination,

N = normality of standard silver nitrate solution, and

W = mass in g of the material out of which the aqueous extract was made (*see* 9.2.1) for chloride content test only.

10 METHOD FOR DETERMINATION OF DENSITY

10.1 Determine the length, width and thickness of the sample as described in 3 and 4.

Weigh the test specimen correct to 0.1 g.

Determine the density of the sample by dividing the mass in grams by the volume in cubic decimetres.

TESTS FOR COIR MATS
DETERMINATION OF ENDS, PICKS, PILE HEIGHT, DIMENSIONS, MASS AND CONSTRUCTION

[*Source* : **IS 11420 (Part 1) : 1985**]

1 SCOPE

1.1 This standard covers methods of tests for determination of ends, picks, pile height, dimen-sions, mass and construction of coir mats.

2 DETERMINATION OF ENDS AND PICKS PER DECIMETRE

2.1 Ends (or Chains) per Decimetre

Lay one test specimen on a horizontal surface with its face downward. Place a scale graduated in centimetres along the width of the test specimen. Count the number of ends (normally comprising one yarn and one space and including as a traction any portion of such unit) in a distance of 1 dm. Determine similarly the number of ends in 1 dm at two other different places.

2.1.1 Calculate the mean of three values obtained as in 2.1 which shall be taken as the number of ends (or chains) per decimetre for the test specimen.

2.1.2 Repeat the test with the remaining test specimens and determine the ends (or chains) per decimetre for each of the test specimen as indicated above.

2.2 Picks per Decimetre

Lay one test specimen on a horizontal surface with its face downwards. Place a scale graduated in centimetre in a direction perpendicular to the weft. Count the number of picks (normally comprising one yarn and one space and including as a traction any portion of such unit) in a distance of 1 dm. Determine similarly the number of picks in 1 dm at two other different places.

2.2.1 Calculate the mean of the three values as obtained in 2.2 which shall be taken as the number of picks per decimetre for the test specimen.

2.2.2 Repeat the test with the remaining test specimens and determine the picks per decimetre for each of the test specimen as indicated above.

3 DETERMINATION OF PILE HEIGHT

3.1 Take one test specimen. Place it on a table or hardboard with its face upwards. Insert a pointed and graduated metal rod through the pile till it just touches the board. Read off the depth of the pile on the rod. Repeat the test at ten different places at least 50 mm away from the edge in the test specimen. Calculate their average. This average value shall be the pile height of the test specimen.

3.2 Repeat the test with the remaining test specimens and determine the pile height of each of the test specimen in the test sample.

4 DETERMINATION OF DIMENSIONS

4.1 Place the test specimen upside down. Measure the length and width from edge to edge (including braid) at four places uniformly distributed along the test specimen. Calculate separately the average of length and width so measured.

4.2 Repeat the test with the remaining test specimens and determine the average length and width of each test specimen in the test sample.

5 DETERMINATION OF MASS

5.1 Weigh each test specimen accurate up to 10 g the dimensions of which have been determined in accordance with 4 and calculate its mass in grams per square metre.

6 DETERMINATION OF CONSTRUCTION

6.1 Cut one test specimen in the direction of its weft. Pull out one pick and note the number of strands in the picks. Pull out the piles one by one in one row and note the number of strands in each pile. Similarly, note the number of strands in the picks and the number of strands in the pile for five successive picks and five rows of piles.

6.2 The test specimen shall be considered to be in conformity with the requirements if all the observed values are equal to the values specified.

6.3 Repeat the test with the remaining test specimens.

TESTS FOR COIR MATTINGS, MOURZOUKS AND CARPETS DETERMINATION OF ENDS, PICKS, DIMENSIONS AND MASS

[*Source* : **IS 12503 (Part 1) : 1988**]

1 SCOPE

This standard covers methods of tests for determination of ends, picks, dimensions and mass of coir mattings, mourzouks and carpets.

2 DETERMINATION OF ENDS AND PICKS PER DECIMETRE

2.1 Ends per Decimetre

Lay one test specimen on a horizontal surface and smoothen it out. Place a scale marked in centimetre along the width of the test specimen. Count the number of ends (normally comprising one yarn and one space and including as a fraction any portion of such unit) in a distance of one decimetre. Determine similarly the number of ends in one decimetre at two other different places.

Calculate the mean of three values as detained above which shall be taken as the number of ends per decimetre for the test specimen.

Repeat the test with the remaining test specimens and determine the ends per decimetre for each of the test specimen in accordance with the above procedure.

NOTE — In case it is not possible to count the number of ends in mourzouks, cut the test specimen at one and, pullout weft threads to a distance ot about 5 cm and count the protruding warp threads.

2.2 Picks per Decimetre

Lay one test specimen on a horizontal surface and smoothen it out. Place a scale graduated in centimetre in a direction perpendicular to the weft. Count the number of picks (normally comprising one yarn and one space and including as a fraction any portion of such unit) in a distance of 1 dm. Determine similarly the number of picks in 1 dm at two other different places.

Calculate the mean of the three values as obtained above which shall be taken as the number of picks per decimetre for the test specimen.

Repeat the test with the remaining test specimens and determine the picks per decimetre for each of the test specimen in accordance with the above procedure.

3 DETERMINATION OF DIMENSIONS

3.1 Place the test specimen on a horizontal surface. Measure the length and width from edge to edge (including sealing at the edge) at four places uniformly distributed along the test specimen. Calculate separately the average of length and width so measured.

Repeat the test with the remaining test specimens and determine the average length and width of each test specimen in the test sample.

4 DETERMINATION OF MASS

4.1 Weigh each test specimen accurate up to 10 g, the dimension of which has been determined in accordance with 3. Calculate the mass in grams per square metre of the test specimen from the mass as obtained above and the dimensions as obtained in 3.

SECTION D

TESTS FOR TEXTILE FLOOR COVERINGS

TESTS FOR WOOLLEN DRUGGETS DETERMINATION OF ENDS AND PICKS PER DECIMETRE, MASS PER SQUARE METRE, DIMENSIONS AND MASSES OF WARP AND WEFT PER SQUARE METRE

(*Source* : IS 697 : 1963)

1 SCOPE

1.1 This standard prescribes the methods of tests for determination of ends and picks per square metre, dimensions and masses of warp and weft per square metre of woollen druggets.

2 METHOD FOR DETERMINATION OF ENDS AND PICKS PER DECIMETRE

2.1 Test Specimens

For the purpose of this test all pieces in the sample under test shall constitute the test specimens.

2.2 Procedure

2.2.1 *Ends per Decimetre*

Lay one of the druggets constituting the sample under test on a horizontal surface without stretching it. Place a correctly marked scale on the drugget in line with (a) the first, and (b) the last woollen weft from where the warp ends emerge to form fringes and count the actual number of ends in 10 cm. Take four readings, two on each side of the drugget. Calculate the average of the four readings.

Repeat the test with the remaining druggets constituting the sample under test.

2.2.2 *Picks per Decimetre*

Lay one of the druggets constituting the sample under test on a horizontal surface in the manner described under 2.2.1. Place a correctly marked scale on the drugget along the selvedge and count the number of picks in 10 cm. Take four readings, two on each selvedge of the drugget. Calculate the average of the four readings.

Repeat the test with the remaining druggets constituting the sample under test.

2.3 Report

2.3.1 Report the lot to be in conformity with the requirements of the standard, if the test values satisfy the conditions prescribed in the standard.

3 METHOD FOR DETERMINATION OF MASS PER SQUARE METRE

3.1 Test Specimens

For the purpose of this test all druggets in the sample under test shall constitute the test specimens.

3.2 Procedure

3.2.1 Weigh one drugget to the nearest 10 g. From (a) the weight obtained as above, and (b) its length and width obtained as in 5.2.1 and 5.2.2 calculate correct to the nearest 10 g its mass per square metre.

Determine similarly the weight per square metre of all the remaining druggets constituting the sample under test.

3.3 Report

Report the lot to be in conformity with the requirements of the standard, if the test values satisfy the conditions prescribed in the standard.

4 METHOD FOR DETERMINATION OF THE MASSES OF WARP AND WEFT PER SQUARE METRE

4.1 Swatches

From each drugget constituting the sample under test one swatch slightly larger than 1 m^2 in area shall be cut off and conditioned as prescribed in 4.3.

4.2 Atmospheric Conditions for Testing

The test shall be carried out in a standard atmosphere at 65 ± 2 percent relative humidity and 27 ± 2°C temperature or within a period of five minutes of the removal of the swatches from the standard atmosphere.

4.3 Conditioning of Swatches

Prior to evaluation, the swatches shall be conditioned to moisture equilibrium in the standard atmosphere (*see* 4.2).

When the swatches have been left in such an atmosphere for 48 hours in such a way as to expose, as far as possible, all portions of the swatches to the atmosphere, they shall be deemed to have reached moisture equilibrium.

4.4 Test Specimens

From each swatch drawn as in 4.1 and conditioned as in 4.3, one test specimen measuring 1 m^2 shall be either stamped out or cut by means of a template and razor blade, in such a manner as to exclude the selvedge and the fringes.

4.5 Procedure

Unravel one test specimen and pull out carefully the warp and the weft yarns and weigh each separately in grams. Repeat the test with the remaining test specimens.

4.6 Report

Report the lot to be in conformity with the requirements of the standard if the test values satisfy the conditions prescribed in the standard.

NOTE — In case the size of druggets is such that the swatches of the size mentioned in 4.1 cannot be obtained, condition, as prescribed in 4.3 the test sample and cut test specimens of the largest size practicable (*see* 4.4) and evaluate them as prescribed in 4.5. Calculate the mass of warp per square metre, and the mass of weft per square metre from the mass values and the actual dimensions of the test specimens.

5 METHOD FOR DETERMINATION OF LENGTH AND WIDTH

5.1 Test Specimens

For the purpose of this test all the pieces in the sample under test shall constitute the test specimens.

5.2 Procedure

5.2.1 *Length*

Lay a drugget on a flat surface and render it free from all creases and wrinkles. With a metallic measuring tape measure correct to the nearest one centimetre the length of the drugget, excluding the fringes, at three different places uniformly distributed along the width of the drugget. Calculate the average of the three readings and round off to the nearest centimetre.

5.2.2 *Width*

With a metallic measuring tape measure correct to the nearest one centimetre the width of the same drugget, including the two selvedges, at four different places uniformly distributed along the length of the drugget. Calculate the average of the four readings and round off to the nearest centimetre.

5.3 Report

Report the lot to be in conformity with the requirements of the standard, if the test values satisfy the conditions prescribed in the criteria for the conformity of the standard.

TESTS FOR HAND-MADE *NAMDHAS* DETERMINATION OF SIZE, MASS OF EMBROIDERY YARN AND FELT, AND PERCENTAGE OF WOOL

(*Source* : IS 4392 : 1967)

1 SCOPE

1.1 This standard prescribes the methods of tests for determination of size, mass, mass of embroidery yarn and felt, and percentage of wool of hand-made *NAMDHAS*.

2 ATMOSPHERIC CONDITIONS FOR TESTING AND CONDITIONING OF TEST SAMPLE

2.1 All tests shall be carried out in the prevailing atmospheric conditions and prior to test, the samples shall be conditioned in the same prevailing atmosphere for at least 24 hours. The relative humidity and temperature of the prevailing atmosphere shall be reported in the test report.

3 SIZE

3.1 Method A — For Square and Rectangular *NAMDHAS*

3.1.1 *Length*

Take a test specimen and lay it on a flat surface and render it free from all creases and wrinkles. With a metallic measuring tape, measure correct to the nearest centimetre the length of the *NAMDHA*, excluding fringes, if any, at three different places uniformly distributed along the width of the *NAMDHA*. Calculate the average of the three readings.

3.1.2 *Width*

With a metallic measuring tape, measure correct to the nearest centimetre the width of the same *NAMDHA* excluding fringes, if any, at three different places uniformly distributed along the length of the *NAMDHA*. Calculate the average of the three readings.

3.2 Method B — For Circular *NAMDHAS*

Take a test specimen and lay it on a flat surface and render it free from all creases and wrinkles. With a metallic measuring tape, measure correct to the nearest centimetre the diameter of the *NAMDHA* excluding fringes at four different points distributed along the peripheri. Calculate the average of the four readings.

NOTE — To facilitate the measurement of diameters the centre of the *NAMDHA* may be determined by first folding the *NAMDHA* into half and then refolding it into further half, thus making it into a quarter size. The point where the two folds cross be taken as the centre of the NAMDHA.

3.3 Method C — For Oval *NAMDHAS*

3.3.1 *Major and Minor Axes*

Take a test specimen and lay it on a flat surface and render it free from all creases and wrinkles. With a metallic measuring tape, measure correct to the nearest centimetre the major axis and minor axis of the *NAMDHAS*. Take at least two readings in each case and calculate the average of the readings taken for major and minor axes.

NOTE — To facilitate the measurement of major and minor axes the centre of the *NAMDHA* may be determined by first folding the *NAMDHA* into half along the major axis and then refolding it into further half along the minor axis, thus making it into a quarter size. The point where the two folds cross be taken as centre of the *NAMDHA*.

4 MASS

4.1 Procedure

Take one test specimen. With the help of a suitable balance, determine its mass correct to the nearest 10 g. Similarly determine the weight of other *NAMDHAS* under test.

5 MASS OF EMBROIDERY YARN AND FELT

5.1 Procedure (*see also* Note under 5.1.4)

5.1.1 Take one of the two test specimens and lay it flat on a surface. With the help of a sharp razor, cut the embroidery yarn at places and pull out all the embroidery yarn gently, thus separating the embroidery yarn from the felt.

5.1.2 Determine the mass of the embroidery yarn obtained as in 5.1.1, correct to the nearest 2 g.

5.1.3 Determine the mass of felt obtained as in 5.1.1, correct to the nearest 5 g.

5.1.4 Determine similarly the mass of embroidery yarn and mass of the remaining felt *NAMDHA* and calculate the average separately.

NOTE — The mass of felt may also be checked at the time of manufacture by determining the mass of felt before embroidery is done on it The mass of embroidery yarn would also be verified when the finished mass of the *NAMDHA* is determined since the difference between the mass of finished *NAMDHA* and felt would give the mass of embroidery yarn used.

6 PERCENTAGE OF WOOL

6.1 From each felt obtained as in 5.1.1, cut out a minimum of 3 pieces of at least 15 × 15 cm from different portions excluding the fringes. Dissect these pieces into smaller pieces. Mix them thoroughly and take a representative test specimen weighing about 5 g. Extract it in a Soxhlet apparatus with light petroleum for one hour at a minimum rate of 6 cycles per hour. Allow the light petroleum to evaporate and then extract the specimen in a Soxhlet apparatus with water for two hours at a minimum rate of 6 cycles per hour.

6.2 Place the specimen in the drying oven maintained at a temperature of 105 to 110°C and dry it to a constant mass. The weight shall be taken as constant when the difference between the two successive weighings made at intervals of 20 minutes is less than 0.05 percent.

6.3 Determine the mass of the specimen without removing it from the oven. In case the drying oven is not provided with the weighing balance, remove the specimen from the oven and transfer it to weighing container of known mass provided with a light lid. The transference of the specimen should be done in as less a time as possible. Cool the specimen and the container in a desiccator to room temperature before weighing. Weigh the container and then find the mass of the specimen to an accuracy of 10 mg.

6.4 Put the specimen in a beaker together with at least 100 times its weight of 5 percent solution of sodium or potassium hydroxide and boil slowly until the wool fibres become gelatinous and dissolve. After a period of 10 minutes of boiling, filter through a Gooch crucible and wash the residue first with warm water, then with 0.1 N solution of glacial acetic acid and finally with hot water. Dry the residue at 105 to 110°C.

6.5 Examine carefully the residue and the pores of the crucible for non-fibrous matter, for example, burrs, seeds, finishing material, dyestuff residues as well as for incompletely dissolved wool. If any such contaminant is present, it shall be dissolved or otherwise removed. For example, undissolved wool protein be removed by treatment with fresh boiling 5 percent sodium or potassium hydroxide, burrs and seeds be lifted out with forceps. Rinse and dry the residue at 105 to 110°C to constant mass and weigh it to an accuracy of 10 mg.

6.6 From the mass of the specimen and residue, determine the percentage of wool by the following formula:

$$\text{Percentage of wool} = \frac{100\,(a-b)}{a}$$

where

a = oven-dry mass of the specimen, and

b = oven-dry mass of the residue.

TESTS FOR HAND-MADE WOOL CARPETS DETERMINATION OF LENGTH AND WIDTH, COLOUR FASTNESS, PERCENTAGE OF WOOL, PILE DENSITY AND FLAMMABILITY

(*Source* : IS 5641 : 1973)

1 SCOPE

1.1 This standard prescribes the methods of tests for determination of length and width, colour fastness, percentage of wool, pile density and flammability of hand-made wool carpets.

2 LENGTH AND WIDTH

2.1 Length

Lay the carpet on a flat surface and render it free from all creases and wrinkles. With a metallic measuring tape, measure correct to the next lower full centimetre the length of the carpet, excluding the fringes, at a sufficient number of places such that no two adjacent places are more than one metre apart. Take the minimum measurement so obtained as the length of the carpet.

2.2 Width

With a metallic measuring tape, measure correct to the next lower full centimetre the width of the carpet, excluding the selvedges, at a sufficient number of places such that no two adjacent places are more than one metre apart. Take the minimum measurement so obtained as the width of the carpet.

3 COLOUR FASTNESS

3.1 Determine the colour fastness ratings of pile yarn to light, water, organic solvents and dry rubbing by the methods prescribed against each.

NOTE — These test methods are also available in SP 15 (Part 4) : 1988

4 PERCENTAGE OF WOOL

4.1 Take a sample of pile yarn removed from the loom or from the carpet sample taking care that only pile is cut and backing material is not included. Extract it in a Soxhlet apparatus with light petroleum for one hour at a minimum rate of 6 cycles per hour. Allow the light petroleum to evaporate and then extract the sample in a Soxhlet apparatus with water for two hours at a minimum rate of 6 cycles per hour.

4.2 Take a representative specimen weighing about 5 g from the pretreated sample and place it in a suitable container. Place the specimen in the drying oven maintained at a temperature of 105 ± 3°C and dry it to a constant mass. The mass shall be taken as constant when the difference between the two successive weighings made at intervals of 20 minutes is less than 0.05 percent.

4.3 Determine the mass of the specimen without removing it from the oven. In case the drying oven is not provided with the weighing balance, remove the specimen from the oven and transfer it to a weighing container of known mass provided with a light lid. The transference of the specimen should be done in as little a time as possible. Cool the specimen and the container in a desiccator to room temperature before weighing. Weigh the container and then find the mass of the specimen to an accuracy of 10 mg.

4.4 Put the specimen in a beaker together with at least 100 times its mass of 5 percent solution of sodium or potassium hydroxide and boil slowly until the wool fibres become gelatinous and dissolve. After a period of 10 minutes of boiling, filter through a Gooch crucible and wash the residue first with warm water, then with 0.1 N solution of glacial acetic acid and finally with hot water. Dry the residue at 105 ± 3°C.

4.5 Examine carefully the residue and the pores of the crucible for non-fibrous matter, for example, burrs, seeds, finishing material, dyestuff residues as well as for incompletely dissolved wool. If any such contaminant is present, it shall be dissolved or otherwise removed. For example, undissolved wool protein be removed by treatment with fresh boiling 5 percent sodium or potassium hydroxide and burrs and seeds be lifted out with forceps. Rinse and dry the residue at 105 ± 3°C to constant mass and weigh it to an accuracy of 10 mg.

4.6 From the mass of the specimen and residue, determine the percentage of wool by the following formula:

$$\text{Percentage of wool} = \frac{100\,(a-b)}{a}$$

where

a = oven-dry mass of the specimen, and

b = oven-dry mass of the residue.

5 PILE DENSITY

5.1 Number of Knots

Count the number of warp threads per metre width (say A) and the number of rows per metre length of the carpet (say B). The average number of knots per square metre shall be calculated as given below:

a) In case the knotting and weaving of carpet is according to Method I:

$$\text{Knots/m}^2 = 0.5 \times A \times B$$

b) In case the knotting and weaving of carpet is according to Methods II, III or V:

$$\text{Knots/m}^2 = 0.25 \times A \times B$$

c) In case the knotting and weaving of carpet is according to Method IV:

$$\text{Knots/m}^2 = 0.375 \times A \times B$$

5.2 Count of Yarn

Take one of the piles removed from the carpet, straighten it without unduly stretching it and determine its length correct to the nearest millimetre. Similarly, determine the length of other piles and find the total length. Determine the total mass of all these piles correct to an accuracy of 10 mg. From the length and mass of piles calculate the count of yarn by the following formula:

$$t = 1\,000 \times \frac{w \times 100}{l}$$

where

t = count of pile yarn in tex,

w = weight in grams, and

l = length in centimetres.

NOTE — The weight of pile yarn shall be determined by adding a moisture regain of 18.25 percent to the oven-dry mass.

5.3 Calculation

Calculate the pile density from the number of knots per square metre (5.1) and the count of yarn (5.2) by the following formula:

$$\text{Pile density} = \frac{n \times 2 \times t}{1\,000 \times 1\,000}$$

where

n = number of knots per square metre, and

t = count of pile yarn in tex.

6 FLAMMABILITY TEST

6.1 Cut a representative sample from the carpet of approximate size of 25 × 25 cm. Dry it in an oven at 105 ± 3°C for 2 hours and cool for 30 minutes in a desiccator. Place a hexamethylene tetramine tablet (time burning tablet having burning time of approximately 2.5 minutes) in the centre of the sample and ignite it.

6.2 If the flame does not spread by more than 7.5 cm from the tablet in any direction, the carpet shall be deemed to pass the flammability test.

TESTS FOR TUFTED WOOL CARPETS DETERMINATION OF PILE DENSITY AND TUFT WITHDRAWAL FORCE

(*Source* : IS 5884 : 1987)

1 SCOPE

1.1 This standard prescribes the methods of tests for determination of pile density and tuft withdrawal force of tufted wool carpets.

2 ATMOSPHERIC CONDITIONS FOR TESTING AND CONDITIONING OF TEST SPECIMENS

2.1 The tests shall be carried out in a standard atmosphere of 65 ± 2 percent relative humidity and 27 ± 2°C temperature.

2.2 Prior to testing, the test specimens shall be conditioned to moisture equilibrium in the standard atmosphere. When the test specimens have been left in such an atmosphere for 72 hours in such a way as to expose, as far as possible, all portions of the test specimens to the atmosphere, they shall be deemed to have reached moisture equilibrium.

3 DETERMINATION OF PILE DENSITY

3.1 Test Specimens

3.1.1 Cut four specimens, each at least 200 × 200 mm with the two sides parallel and the other two perpendicular to the selvedge.

3.1.2 If there is any tendency for the edges to fray, seal them with adhesive and allow to dry. Condition the specimens to constant mass in the standard atmosphere.

3.2 Apparatus

3.2.1 *Carpet Shearing Machine*

Capable of shearing the pile close to the backing of the carpet.

3.2.2 *Carpet Thickness Tester*

a) should have a circular plane presser-foot of area between 300 and 1 000 mm^2.

b) should be capable of exerting a pressure of 20 gf/cm^2 normal to the plane of the specimen.

c) should be capable of measuring thickness to any accuracy of 0.1 mm over a range of 25 mm.

3.2.3 *Sharp Pointed Knife*

3.2.4 *Measuring Scale,* graduated in millimetres.

3.2.5 *Weighing Balance,* to weigh to an accuracy of 10 mg.

3.2.6 *Press and Cutter,* of known area of at least 10 000 mm^2, which may be circular or square in shape.

3.3 Test Procedure

3.3.1 Measure the thickness of each specimen at 5 places under the standard pressure of 20 gf/cm^2.

3.3.2 Determine the mass of pile using the method given below before the edges of the pile have been sealed as given in 3.1.2.

a) Weigh each specimen to the nearest 10 mg (M_1);

b) Measure the length and width at four places on the back of each specimen to the nearest mm.

c) Shear the pile from the specimen using forward strokes with the clipper in all directions. Shear as close as possible to the backing by running the points of the comb and cutter along the backing without digging in. Avoid plucking any tufts or damaging the backing yarn. Brush, blow or suction clean the specimen during and after shearing. Continue shearing until no further significant amount of pile yarn dust appears on the shearing blades or flies away when the specimen is shaken. It is not necessary to shear to the edges of the specimen provided the area of at least 10 000 mm^2 in the centre is closely shorn.

d) After shearing, cut the area of 10 000 mm^2 from the centre of each specimen using a cutter. The backing yarns in this area shall be undamaged and no tufts shall have been plucked from it.

e) Condition each area cut out of the shorn carpet specimen in the standard atmosphere until successive weighings at intervals of 2 hours show no progressive change greater than 0.25 percent. Record the final conditioned mass of the shorn area to the nearest 10 mg (M_2)

f) From the measurements made in (b), calculate for each specimen the average length and width and the area in square millimetres (A_1).

g) Calculate the total mass per square millimetre of carpet for each specimen

$$\text{Separately } \frac{(M_1)}{(A_1)}.$$

h) Measure the area of the specimen cut out of shorn carpet (A_2).

j) For each area of shorn carpet, calculate the

$$\text{mass per square millimetre} \frac{(M_2)}{(A_2)}.$$

k) For each specimen, calculate the shorned mass of pile above unit area of backing, using the formula:

$$10^6 = \left\{\frac{M_1}{A_1} - \frac{M_2}{A_2}\right\} \quad g/m^2$$

where

$\frac{M_1}{A_1}$ = mass per mm^2 of carpet before shearing,

and

$\frac{M_2}{A_2}$ = mass per mm^2 of carpet after shearing.

m) Calculate the mean value of the shorned mass of pile above unit area of backing from the values obtained from all the specimens (M).

3.3.3 Measure the thickness of each shorn specimen as obtained in 3.3.2 (d) at 5 places under the standard pressure of 20 gf/cm^2.

3.4 Calculations

3.4.1 For each specimen, calculate the mean thickness unshorn and the mean thickness shorn. Calculate for each specimen the thickness of pile as the difference between these figures in mm to the nearest 0.02 mm. Calculate the mean value of pile thickness for all the specimens in mm to the nearest 0.1 mm (t).

3.4.2 The pile density (in g/m^2 per mm pile thickness) shall be calculated by dividing the mean value of mass of pile above unit area of backing (M) by mean value of pile thickness (t).

4 DETERMINATION OF TUFT WITHDRAWAL FORCE

4.1 Apparatus

4.1.1 Tensile testing apparatus with suitable ranges and an accuracy of ± 5 percent. Full scale loads ranging from 0.5 to 10.0 kgf are generally adequate.

4.1.2 Apparatus shall preferably have a constant rate of loading but alternatively, constant rate of traverse or extension may be used. In any case the average test time for achievement of the maximum withdrawal force of the tufts and loops tested should be between 5 and 10 seconds. This may be achieved in machines which would give very short test time, for example, those using load cells, by inserting a spring between the loading mechanism and the specimen.

4.1.3 The apparatus shall have a means of clamping a specimen of carpet to a base plate so that it is flat in a plane perpendicular to the direction of pull upon the tuft or loop. The flat, horizontal part of the clamp, which is brought into contact with the specimen during testing, shall be at least 60 mm × 60 mm, shall have a circular cut out of 12 mm radius around the tuft, or loop to be withdrawn and shall retain the specimen inside this cut-out area (*see* Fig. 1). The cut out may have a throat to allow easier positioning of the specimen with the tuft grip or hook attached.

4.1.4 For cut pile carpets, a suitable means of its selecting and gripping one end of a tuft shall be provided (for example, surgical forceps) and for loop pile carpets, a suitable hook (for example, a knitting machine needle) is required. These tufts grips are attached to the upper jaw of the tensile testing apparatus.

4.1.5 The load sensing mechanism of the machine shall be calibrated with the tuft grip or hook in, position.

4.2 Test Samples and Specimens

Samples shall be selected from at least five places across the width of the carpet. Samples shall be conditioned as mentioned in 2.2. Specimen should be cut (one from each sample) to a. size which is convenient for clamping on the testing machine and which will allow for at least 10 tufts to be removed from each. No tufts shall be removed from within 25 mm of the edge of a specimen or of any previously withdrawn tuft.

4.3 Procedure

4.3.1 *Cut Pile Carpets*

Select one end of one tuft and attach the tuft grip. Clamp the specimen firmly and attach the tuft grip to the upper jaw. Set the machine in motion and withdraw the tuft completely in a direction essentially perpendicular to that of carpet specimen. Check that only one complete tuft is withdrawn, and record the maximum force.

4.3.2 *Loop Pile Carpets*

Select a suitable loop and engaged the hook under the top of it. Clamp the specimen firmly and attach the hook to the upper jaw. Set the machine in motion to move the hook in a direction essentially perpendicular to that of carpet specimen, and stop it as soon as slippage occurs in the bend holding one of the loop sides. Record the maximum force.

4.3.3 Repeat the procedure for a minimum of 20 tufts or loops, spread evenly through available samples, taking care that these are at least 25 mm between the previously withdrawn tuft or from the edge of the specimen.

4.4 Report

Report the average of the tests to the nearest 50 gf as the tuft withdrawal force.

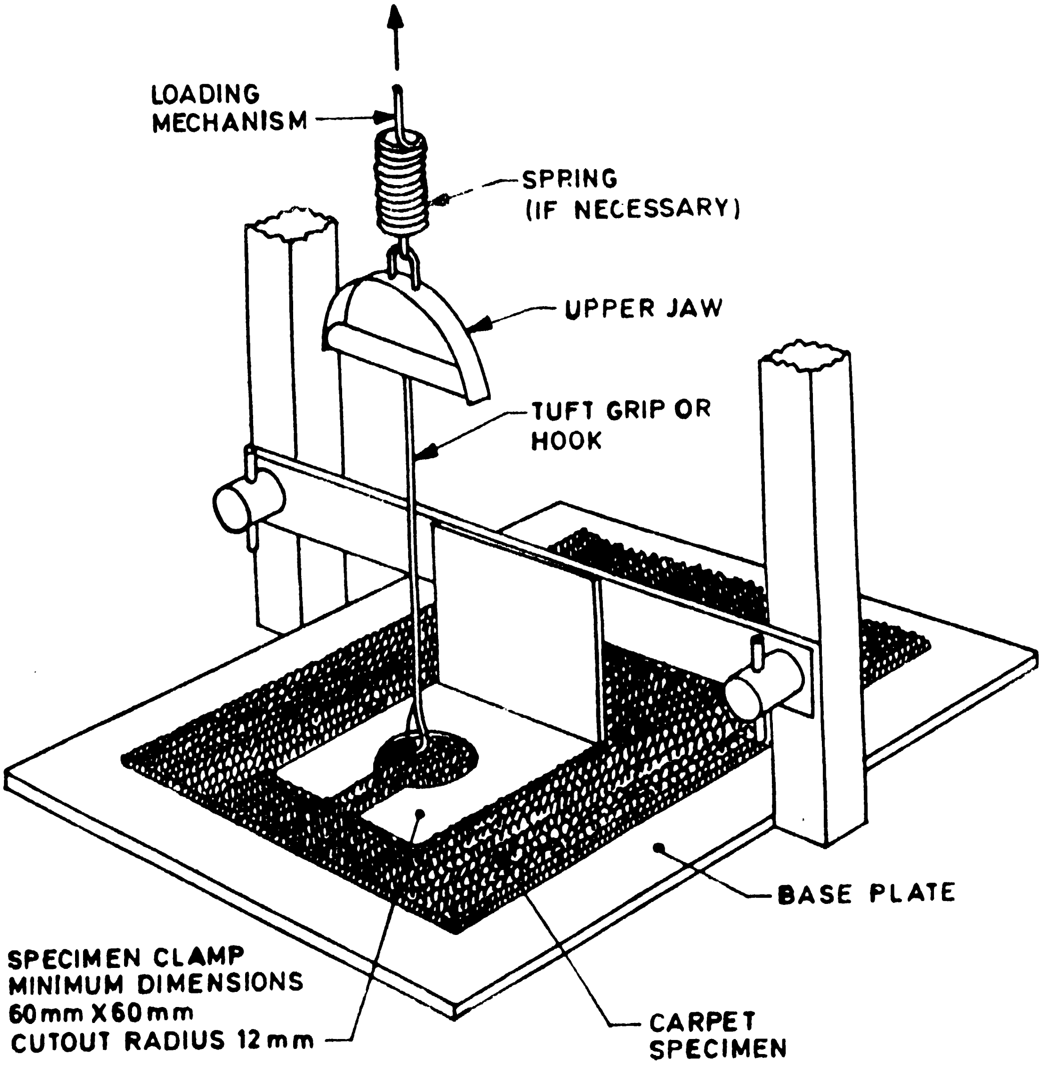


FIG. 1 A TYPICAL FORM OF HORIZONTAL MOUNTING

TESTS FOR HAND-MADE CARPETS DETERMINATION OF TYPE OF KNOTS

[*Source* : **IS 7877 (Part 2) : 1976**]

1 SCOPE

1.1 It describes five types of knots used in the manufacture of hand-made carpets and gives a visual method for their identification.

1.2 All the knots made in Indian carpets are either Persian knots or derivation of the same.

2 AREAS OF TEST

2.1 The number of measurements and areas of test (except colour fastness) shall depend on the size of the carpet as given below:

Size of the Carpet	*Minimum Number of Measures*	*Area of Test*
Up to and including 6 m^2	5	*see* Fig. 1A
Above 6 m^2 and up to 14 m^2	6	*see* Fig. 1B
Above 14 m^2	9	*see* Fig. 1C

3 DESCRIPTION OF TYPES OF KNOTS

3.1 Single Knots

Single knots are of two types, namely, Type I and Type II.

3.1.1 *Type I* (*see* Fig. 2) — For this type, the weaver:

a) makes knots by

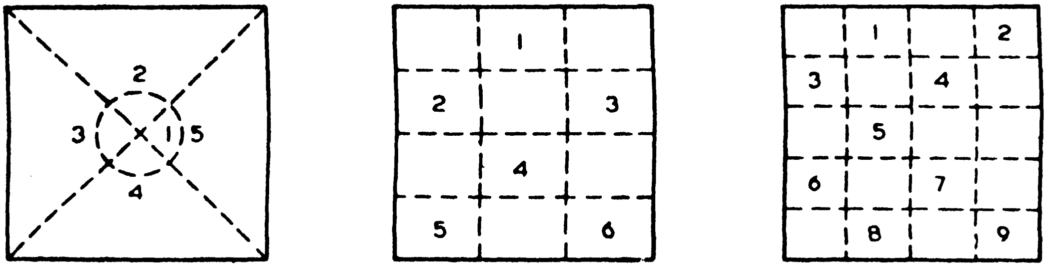
   1) looping a strand of pile yarn around a (the first) warp thread,

   2) passing the strand under the adjacent (the second) warp thread to the left of the first warp thread, and

   3) pulling up the strand and cutting it; and

b) weaves the backing between two adjacent rows of knots by laying two (or more) weft threads, interlacing each with warp threads as in a plain weave.

NOTE — The two weft threads, one over the row of knots and the other under it, shall be inserted in the opposite sheds.



1A 1B 1C

FIG. 1 AREAS OF TEST

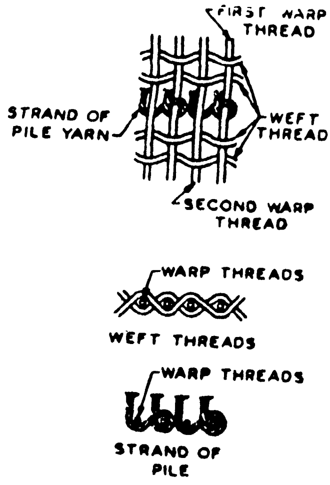


Fig. 2 Type I

3.1.2 *Type II* (*see* Fig. 3) — For this type, the weaver

a) makes knots by

   1) looping a strand of pile yarn around a (the first) pair of warp threads,

   2) passing the strand under the adjacent (the second) pair of warp threads to the left of the first pair of warp threads, and

   3) pulling up the strand and cutting it; and

b) weaves the backing between two adjacent rows of knot by laying two (or more) weft threads, interlacing each with pairs of warp threads as in a basket weave (a weave repeating on two pairs of warp threads and two weft threads).

NOTE — The two weft threads, one over the row of knots and the under it, shall be inserted in the opposite sheds

3.2 Double Knots

Double knots are of three types, namely, Types III, IV and V

3.2.1 *Type III* (*see* Fig. 4)

For this type, the weaver makes knots as in Type II and weaves the backing as in Type I.

3.2.2 *Type IV* (*see* Fig. 5)

For this type, the weaver

a) makes knots by

1) looping a strand of pile yarn around a (the first) warp thread,

2) passing the strand above the adjacent (the second) warp thread to the left of the first warp thread,

3) passing the strand behind the adjacent (the third) warp thread to the left of the second warp thread,

4) pulling up the strand and cutting it,

b) makes the second knot as in (a) above after leaving the adjacent (the fourth) warp thread to the left of the third warp thread; and

c) weaves the backing as in Type I

3.2.3 *Type V* (*see* Fig. 6) — For this type, the weaver

a) makes some knots as in Type I and the remaining as in Type II, and

b) weaves the backing as in Type I.

NOTE — Type V of knots is used only in figured carpets.

4 PROCEDURE FOR IDENTIFYING TYPES OF KNOTS

4.1 Bend the face of the carpet in such a way that pile formed by the two adjacent rows of tufts is pushed apart thus revealing bases of these tufts. Visually examine the knots carefully using a suitable magnifying glass, if necessary, and determine which type of knot has been used.

4.2 Similarly examine the knots in the different areas of carpet.

5 REPORT

5.1 Report the type of knots identified to which the arrangement of knots corresponds and a reference to this standard.

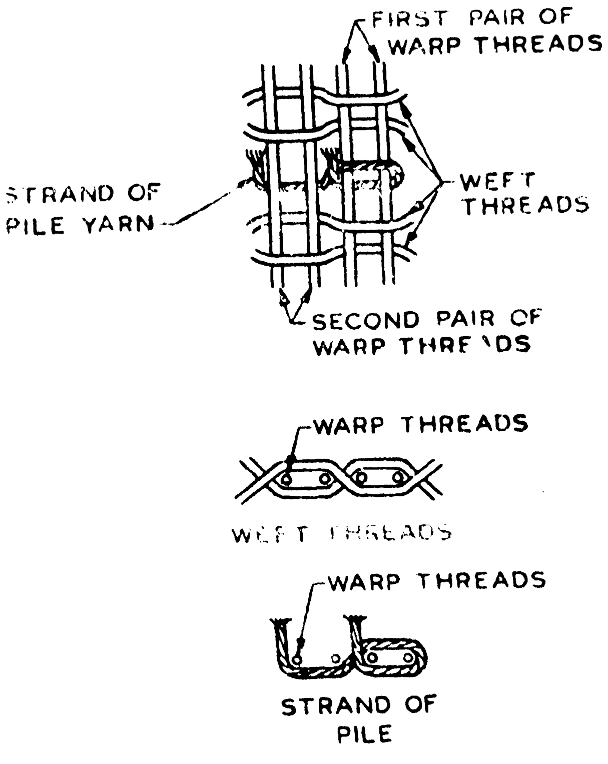


FIG. 3 TYPE II

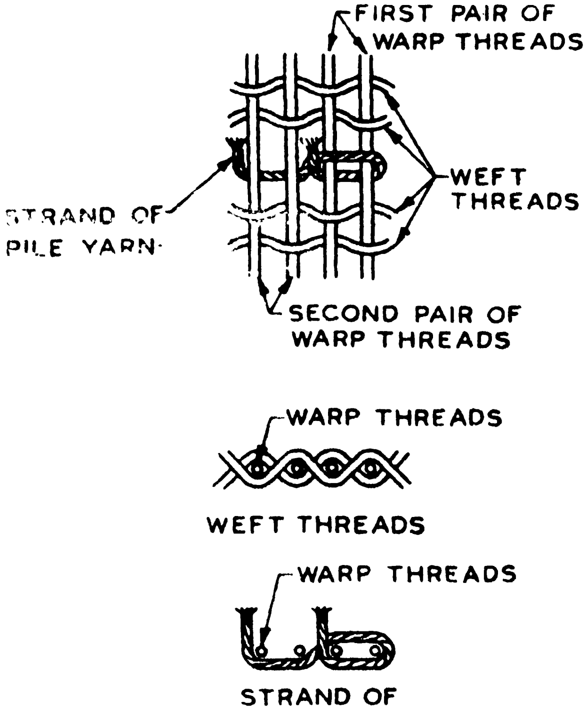


FIG. 4 TYPE III

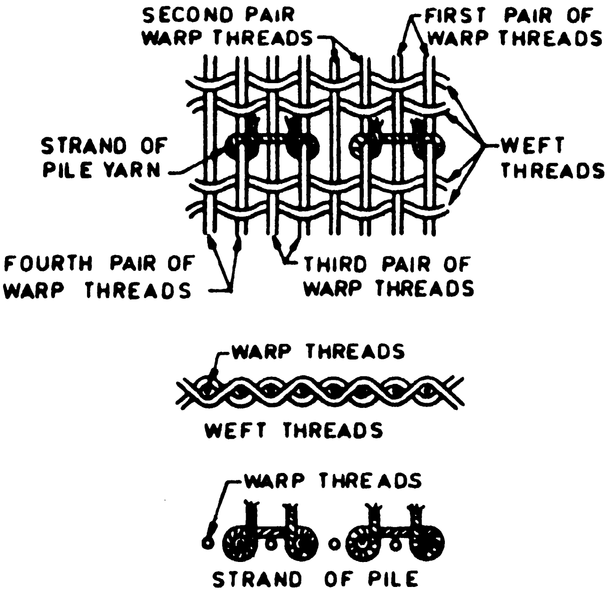


Fig. 5 Type IV

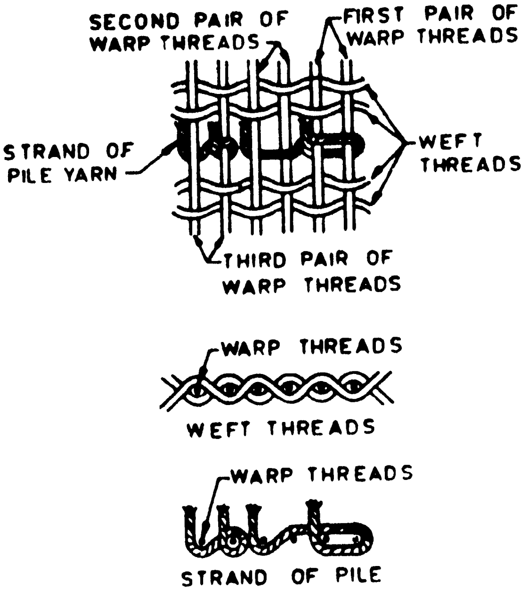


Fig. 6 Type V

TESTS FOR HAND-MADE CARPETS DETERMINATION OF NUMBER OF KNOTS

[*Source* : IS 7877 (Part 3) : 1976]

1 SCOPE

1.1 This standard prescribes a method for determining the number of knots in hand-made carpets.

2 AREAS OF TEST

2.1 Select the areas of test in accordance with 2 of Section D5.

3 APPARATUS

3.1 A rule or instrument capable of measuring to the nearest millimetre shall be used.

4 PROCEDURE

4.1 Take one specimen and count at the back of the carpet 40 knots and measure the distance occupied by them. If the distance is less than 10 cm, continue to count until the knots extend over at least 10 cm.

4.2 Repeat the measurement in the different areas of carpet lengthwise and widthwise.

5 CALCULATIONS

5.1 Calculate the number of knots per decimetre in lengthwise and widthwise directions using the following formula:

$$S \text{ (Lengthwise)} = \frac{100 \times \Sigma N_s}{\Sigma L_s}$$

$$G \text{ (Widthwise)} = \frac{100 \times \Sigma N_g}{\Sigma L_g}$$

where

N_s and N_g are the number of knots in each specimen, and

L_s and L_g are the actual lengths in mm.

Measured in lengthwise and widthwise directions respectively.

5.2 Calculate the number of knots per square decimetre by multiplying the values of S and G obtained above.

6 REPORT

6.1 Report the number of knots per decimetre in warp and weft directions in the carpet as obtained in **5.1** and number of knots per square decimetre in the carpet as obtained in **5.2**.

TESTS FOR HAND-MADE CARPETS DETERMINATION OF PILE HEIGHT

[*Source* : IS 7877 (Part 4) : 1976]

1 SCOPE

1.1 This standard prescribes a method for determination of the pile height, that is, tuft leg length above woven ground.

1.1.1 The tuft leg length above woven ground is the same as pile height when the pile is in the vertical position. Generally, the hand-knotted carpets have unidirectional pile, that is, the tufts lie at an angle to the ground opposite to the direction in which weaving has been proceeded. If the tufts are not measured in vertical position, the observations may not give correct results about the pile height rather it would give the measurement of pile thickness.

2 TERMINOLOGY

2.1 For the purpose of this standard, the pile height (tuft leg length) shall mean the length of pile from the point where it emerges from the woven ground to its free extremity.

3 PRINCIPLE

3.1 The pile height is found by inserting in the pile, at right angles to the woven ground, flat metal gauges of known height and determining which gauge corresponds to the pile height.

4 AREAS OF TEST

4.1 Select the areas of test in accordance with 2 of Section D5.

5 APPARATUS

5.1 Gauges made of flat metal strips of shape as shown in Fig. 1, available in intervals of 1 mm shall be used.

6 PROCEDURE

6.1 Insert a gauge between two rows of pile (tuft legs) ensuring that the firm contact is made with the woven ground. Select for measurement that row of pile lying adjacent to the gauge but towards the end of the carpet last woven. Stroke the pile into vertical position besides the gauge thus giving necessary support to the pile to keep them into vertical position. By successively using in different gauges, select the gauge that corresponds to the pile height. Check that this is the nearest gauge by inserting in the same position gauges a unit higher and lower than selected. Determine the pile height to the nearest millimetre.

6.2 If the carpet, due to its design, contains pile of different heights, determine the pile height at all level portions.

6.3 Repeat the measurement in the different areas of carpet.

7 REPORT

7.1 Calculate the average pile height and report the same to the nearest millimetre.

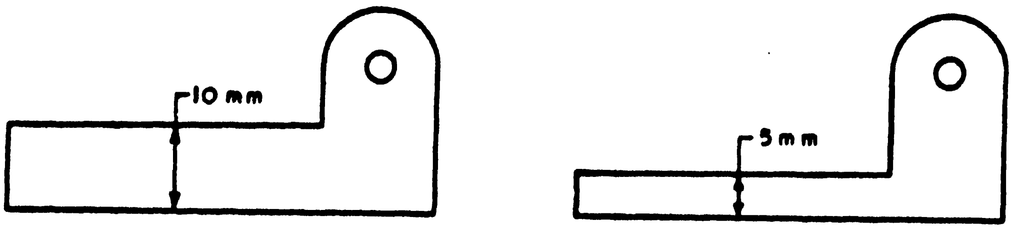


FIG. 1 GAUGES

TESTS FOR HAND-MADE CARPETS DETERMINATION OF DIMENSIONS

[*Source* : **IS 7877 (Part 5) : 1976**]

1 SCOPE

1.1 This standard prescribes a method for determination of length, width and diagonals of rectangular and square carpets, diameter in case of circular carpets and major and minor axes in case of oval-shaped carpets.

2 APPARATUS

2.1 A rule or instrument capable of measuring accurately to the nearest millimetre shall be used.

3 PROCEDURE

3.0 General Instructions

Spread the carpet on a smooth flat surface taking care that no wrinkles are present. Make the measurements between the outer edges of the base of the pile on the opposite edges of the carpet. Make all the measurements to the nearest millimetre.

3.1 Rectangular and Square Carpets

3.1.1 *Length*

Make the measurement in the warp direction in such a way that two measurements are made at an approximately 10 cm within each selvedge of the carpet and one approximately in the middle. Calculate the average length to the nearest 5 mm for carpet measuring up to 100 cm and to the nearest 10 mm for larger carpets.

3.1.2 *Width*

Make five measurements in the weft direction in such a way that two measurements are made at an approximately 10 cm within each edge of the carpet and three measurements made at distances approximately $L/4$, $L/2$ and $3L/4$ from one edge of the carpet (L being the length of the carpet). Calculate the average width to the nearest 5 mm for carpets measuring up to 100 cm width and to the nearest 100 mm for larger carpets.

3.1.3 *Diagonals*

Make the measurements along the line joining the two diagonally opposite corners of the carpet to the nearest 5 mm for carpets having diagonals up to 100 cm and to the nearest 10 mm for larger carpets.

3.2 Circular Carpets

3.2.1 *Diameter*

Make the measurement of the diameter of the carpet at four different points distributed along the peripheri. Calculate the average of the four readings to the nearest 5 mm for carpets measuring up to 100 cm in diameter and to the nearest 10 mm for larger carpets.

NOTE — To facilitate the measurement of diameters the centre of the carpet may be determined by first folding the carpet into half and then refolding it into further half, thus making it into a quarter size. The point where the two folds cross may be taken as the centre of the carpet.

3.3 Oval-Shaped Carpets

3.3.1 *Major and Minor Axes*

Make the measurement of the major and minor axes of the carpet at least two points. Calculate the average of the two readings to the nearest 5 mm for carpets measuring up to 100 cm in major or minor axes as the case may be and to the nearest 10 mm for larger carpets.

NOTE — To facilitate the measurement of major and minor axes the centre of the carpet may be determined by first folding the carpet into half along the major axis and then refolding it into further half along the minor axis thus making it into a quarter size. The point where the two folds cross may be taken as the centre of the carpet.

4 REPORT

4.1 Report the dimensions of carpets as given below:

Rectangular and square carpets	As obtained in 3.1.1, 3.1.2 and 3.1.3
Circular carpets	As obtained in 3.2.1
Oval-shaped carpets	As obtained in 3.3.1

TESTS FOR HAND-MADE BROAD LOOM ROLL CARPETS DETERMINATION OF MASS OF YARN AND PERCENTAGE OF WOOL

(*Source* : IS 7878 : 1975)

1 SCOPE

1.1 This standard prescribes the methods of tests for determination of mass of yarn and percentage of wool of hand-made broad loom roll carpets.

2 MASS OF YARN

2.1 Cut a square portion excluding selvedges and transverse edges of the carpet measuring not less than 20 × 20 cm. Measure it accurately after cutting off the projecting warp and weft threads.

2.2 Condition the test specimens in the standard atmosphere of 27 ± 2°C temperature and 65 ± 2 percent relative humidity.

2.3 Dissect the test specimen. Collect the warp, weft and pile yarns and weigh them separately correct to the nearest gram.

2.4 Calculate the mass of yarn (warp, weft or pile as the case may be) using the following formula:

$$W = \frac{w \times 10\,000}{A \times B}$$

where

W = mass of yarn (g/m^2 of carpet),

w = mass of yarn in the test specimen,

A = length of test specimen (in cm), and

B = width of test specimen (in cm).

3 PERCENTAGE OF WOOL

3.1 Take a specimen of pile yarn removed from the carpet sample taking care that only pile is cut and backing material is not included. Extract it in a Soxhlet apparatus with light petroleum for one hour at a minimum rate of 6 cycles per hour. Allow the light petroleum to evaporate and then extract in a Soxhlet apparatus with water for two hours at a minimum rate of 6 cycles per hour.

3.2 Take a representative sample weighing about 5 g from the pre-treated sample and place it in a suitable container. Place the specimen in the drying oven maintained at a temperature of 105 ± 3°C and dry the sample to a constant mass (which shall be taken as constant when the difference between the two successive weighings made at intervals of 20 minutes is less than 0.05 percent).

3.3 Determine the mass of the specimen without removing it from the oven. In case the drying oven is not provided with the weighing balance, remove the specimen from the oven and transfer it to a weighing container of known mass provided with a tight lid. The transference of the specimen should be done in minimum possible time. Cool the specimen and the container in a desiccator to room temperature before weighing. Weigh the container and then find the mass of the specimen to an accuracy of 10 mg.

3.4 Put the specimen in a beaker together with at least 100 times its mass of 5 percent solution of sodium or potassium hydroxide and boil slowly until the wool fibres become gelatinous and dissolve. After a period of 10 minutes of boiling, filter through a gooch crucible and wash the residue first with warm water, then with 0.1 N solution of glacial acetic acid and finally with hot water. Dry the residue at 105 ± 3°C.

3.5 Examine carefully the residue and the pores of the crucible for non-fibrous matter, for example, burrs, seeds finishing material, dyestuff residues as well as for incompletely dissolved wool. If any such contaminant is present, it shall be dissolved or otherwise removed. For example, undissolved wool protein be removed by treatment with fresh boiling in 5 percent sodium or potassium hydroxide solution and burrs and seeds be lifted out with forceps. Rinse and dry the residue at 105 ± 3°C to constant mass and weigh it to an accuracy of 10 mg.

3.6 Determine the percentage of wool in the test specimen by the following formula:

$$\text{Percentage of wool} = \frac{100\,(a - b)}{a}$$

where

a = oven dry mass of the specimen, and

b = oven dry mass of the residue.

3.7 Similarly, determine the percentage of wool in the remaining test specimens.

TEST FOR MACHINE-MADE CARPETS METHOD FOR DETERMINATION OF DIMENSIONAL CHANGES DUE TO THE EFFECTS OF VARIED WATER AND HEAT CONDITIONS

(*Source* : IS 11471 : 1985)

This test method is adopted from ISO 2551-1981 'Machine made textile floor covering — Determination of dimensional changes due to the effects ot varied water and heat conditions', issued by the International Organization for Standardization (ISO).

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1 SCOPE AND FIELD OF APPLICATION

1.1 This standard prescribes a procedure for the determination of the dimensional changes that take place when machine-made textile floor coverings are subjected to varied water and heat conditions.

1.2 The method is applicable to all machine-made textile floor coverings.

2 PRINCIPLE

2.1 Comparison is made between dimensions of a test specimen after conditioning in the standard atmosphere for testing textiles and then after being subjected to 'specified varied water and heat conditions.

3 APPARATUS

3.1 Instrument Capable of Measuring Length

To the nearest 0.05 mm; for example, optical bench or mechanical device with gauge.

3.2 Plate Glass Sheet

Marginally smaller than the test specimen, or other means of keeping the specimen flat while measurements are made. This will not be required if the instrument in 4.1 incorporates such a glass or metal plate.

3.3 Ventilated Drying Oven

Capable of being controlled at 60 ± 2°C, with perforated and lacquered shelves that can be placed in the oven.

3.4 Steel Pins

Or other appropriate means of indicating the reference points on the test specimen, if necessary.

3.5 Enclosure

To provide the standard atmosphere for testing textiles.

3.6 Container

To hold water at 20 ± 2°C, of dimensions at least 20 mm greater than the test specimen and deep enough to accommodate the submerged test specimen.

4 TEST SPECIMEN

4.1 Sampling

Select the specimens according to the directions in ISO 1957.

4.2 Number and Dimensions

Take at least three test specimens each measuring not less than 250 mm × 250 mm, noting the direction of manufacture.

4.3 Conditioning

Condition the test specimens until they are in equilibrium with the standard atmosphere for testing textiles.

5 PROCEDURE

5.1 Initial Measurement of the Specimen

Make all measurements on the conditioned specimen when it is completely flat; this can be achieved by use of the glass plate (4.2) or other means.

On the conditioned specimen, measure the distance between the edges parallel to the direction of manufacture and between the edges at right angles to the direction of manufacture, each at two locations approximately 200 mm apart. If required by the method of measuring adopted, mark the pair of reference points, for example by the use of steel pins (3.4), approximately 200 mm apart on the edge parallel to the direction of manufacture and also on the edge at right angles to the direction of manufacture. Make all measurements on the back of the specimen to the nearest 0.05 mm.

NOTE — Products made of discrete layers, for example foam-backed constructions, should be measured on both the backing and the use-surface, and the results of both measurements given in the test report.

5.2 Determination

Place the test specimen, lying freely on the perforated and lacquered shelves, in the drying oven (4.3), controlled at 60 ± 2°C. Keep the specimen in the drying oven for 2 h, then remove it and measure the distance between the two parallel edges or the two sets of marks to the nearest 0.05 mm, within between 6 and 7 minutes of removing the specimen from the oven.

Immerse the test specimen, laid flat, in water at a temperature of 20 ± 2°C and allow it to soak in the water for 2 h. Remove the specimen from the water, taking precautions to avoid distorting its shape. Excess moisture may be removed by placing the specimen between sheets of blotting paper. Within 5 ± 1 min of removing the specimen from the water, again measure the distance between the two parallel edges or the two sets of marks as specified in 6.1.

Dry the test specimen for 24 h in the drying oven at 60 ± 2°C in the same conditions as before. Within between 6 and 7 min of removing the specimen from the oven again measure the distance between the two parallel edges or two sets of marks as specified in 6.1.

Finally, leave the test specimen for 48 h in the standard atmosphere for testing textiles. Measure the distance between the two parallel edges or the two sets or marks to the nearest 0.05 mm, note the final appearance of the test specimen, and assess the degree of cockling.

6 EXPRESSION OF RESULTS

6.1 Calculate the arithmetic mean of the dimensions obtained for all specimens in the direction of manufacture and in the direction at right angles to this for each of the stages referred to in 6.

Calculate in each case the variations observed and express as a percentage using the formula

$$\frac{l_m - l_o}{l_o} \times 100$$

where

l_o is the arithmetic mean of the initial measurements;

l_m is the arithmetic mean of measurements at each of the stages referred to in 6.

Indicate shrinkage by a minus sign, and an increase in dimensions by a plus sign.

7 TEST REPORT

7.1 The test report shall include the following particulars:

a) a statement that the procedure was conducted in accordance with this International Standard, and details of any operations not included, or optional;

b) the individual values for each specimen of the measurements made in the direction of manufacture and in the direction at right angles to the direction of manufacture, together with the results obtained as specified in 7,

c) a description of the final appearance of the test specimens, i.e. whether they exhibit mild, moderate or severe cockling;

d) an indication of the type of measuring instrument used.

SECTION E

TESTS FOR INDUSTRIAL TEXTILES

TESTS FOR WOOL FELT (PRESSED) DETERMINATION OF THICKNESS, DENSITY, BREAKING LOAD AND TENSILE STRENGTH, SPLITTING RESISTANCE, ASH CONTENT AND NON-WOOL CONTENT

(*Source* : IS 1719 : 1979)

1 SCOPE

1.1 This standard prescribes the methods of tests for determining the thickness, density, breaking load and tensile strength, splitting resistance, ash content and non-wool content of wool felt (pressed).

2. ATMOSPHERIC CONDITIONS FOR CONDITIONING AND TESTING

2.1 The tests shall be carried out in the standard atmosphere at 27 ± 2°C temperature and 65 ± 2 percent relative humidity.

2.2 Prior to test, the specimens shall be conditioned to moisture equilibrium in the standard atmosphere. When the specimens have been left in such an atmosphere for 48 hours in such a way as to expose as far as possible all portions of the specimens to the atmosphere, they shall be deemed to have reached moisture equilibrium.

3 THICKNESS

3.1 Test Specimens

Each of the samples selected according to the sampling procedure shall constitute test specimens.

3.2 Apparatus

3.2.1 *Micrometer Gauge*

The gauge shall be provided with the following:

a) Circular presser foot,

b) A dial graduated in millimetres to read the thickness of the specimen,

c) Means for adjusting the pressure to be applied on the specimen,

d) Means for adjusting the pointer on the dial to zero position, and

e) Means to enable measurements to be made at any distance greater than 15 cm away from the edge of the specimen.

3.2.2 The gauge shall meet the following requirements:

a) The presser foot shall have an area which is nearest to the value calculated by taking the diameter of the presser foot to be 5 times the estimated or assumed thickness of the felt under test.

b) The dial shall be capable of being read to an accuracy of at least 0.02 mm.

c) The presser foot and the anvil (or lower foot) surfaces shall be plane within 0.002 mm and parallel to each other within 0.002 mm.

d) The gauge shall be capable to provide a pressure up to 5 kPa (*see* Note) on the test specimen.

NOTE — 1 kilopascal (kPa) is approximately equal to 10 gf/cm².

3.3 Procedure

3.3.1 Clean the surfaces of the presser foot and anvil. Adjust the gauge so that it provides the requisite pressure (*see* Note) on the specimen during the test. Set the gauge to read zero when the presser foot rests on the anvil.

NOTE — A pressure of 2 kPa shall be applied in case of medium hard and soft felts and of 5 kPa in case of hard and extra hard felts.

3.3.2 Raise the presser foot and lay a portion of the specimen on the anvil and render it free from wrinkles and creases with no greater tension than is necessary to make it lie flat and straight. Lower the presser foot slowly avoiding jerks or impacts till the requisite pressure (*see* Note under 3.3.1) is applied on the felt. Read the dial immediately after the visible movement of the pointer ceases.

3.3.3 Measure the thickness of the specimen under test at 10 different portions in the manner prescribed in 3.3.2.

3.3.4 Find the average of the 10 readings and note it as the thickness.

4 DENSITY

4.1 Test Specimens

Each of the samples selected according to sampling procedure shall constitute test specimens.

4.2 Procedure

4.2.1 Determine the mass (g/m²) of felt.

4.2.2 Calculate the density of felt by the following formula:

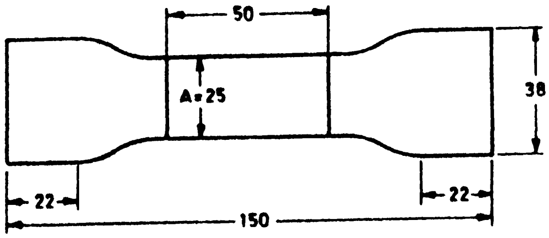
$$\text{Density, g/cm}^3 = \frac{\text{Mass, g/m}^2}{\text{Thickness in mm} \times 10^3}$$

5 BREAKING LOAD AND TENSILE STRENGTH

5.1 Preparation of Test Specimen

Cut four test specimens having the outline shown in Fig. 1 and conforming to the dimensions indicated in the figure from each of the samples selected in the lengthwise and widthwise direction.

Specimens shall be cut so as to cover the entire sample as far as possible.



All dimensions in millimetres.

FIG. 1 TEST SPECIMEN

5.2 Tensile Testing Machine

The machine shall be of such capacity that the maximum load required to break the test specimen shall not exceed 85 percent nor be less than 15 percent of the rated capacity. The rate of traverse of the machine shall be 460 ± 15 mm. The distance between the two grips (gauge length) shall be 75 mm. The machine shall be equipped with a type of grip which tightens automatically and exerts a uniform pressure across the gripping surfaces increasingly as the tension increases so as to prevent uneven slipping and to favour breakage of the specimen in its constricted section. It is advisable to have at the end of each grip a positioning device so that all specimens are inserted to the same depth in the jaws and are perpendicular to the direction of the pull. The machine shall be power-driven.

5.3 Procedure

5.3.1 *Breaking Load*

Insert a test specimen into the grips of the tensile testing machine taking care to adjust it symmetrically so that the tension will be distributed uniformlly over the cross-section. (If tension is greater on one side of the test specimen than on the other, reference lines will not remain parallel and the maximum strength will not be developed.) Start the machine and note the load developed on the test specimen when it breaks. Repeat the test with the remaining test specimens and calculate the average breaking load in respect of each simple.

5.3.2 *Tensile Strength*

Calculate the tensile strength of felt by the following formula:

$$\text{Tensile strength, N/mm}^2 = \frac{L}{t \times W}$$

where

L = breaking load in N;

t = thickness in mm; and

W = minimum width of the narrow portion (*see* '*A*' in Fig. 1), in mm.

6 SPLITTING RESISTANCE

6.1 Preparation of Test Specimen

Cut four test specimens of 2.5 × 15 cm size from different portions of each of the samples selected in the lengthwise and widthwise direction.

6.2 Tensile Testing Machine

See 5.2

6.3 Procedure

6.3.1 Split the specimen within the middle third of the thickness for a distance of approximately 5 cm from one end only. Clamp the lips in each jaw of the testing machine bringing the jaws close enough for the purpose. Start the machine and record the load as splitting resistance in newtons necessary to pull the two sections of the specimen wholly apart.

6.3.2 Repeat the test with the remaining test specimens and calculate the average splitting resistance in respect of each sample.

7 ASH CONTENT

7.1 Test Specimens

Draw one test specimen weighing approximately 4 g from each of the test samples selected. The test specimen shall consist of small swatches cut right through the thickness from different parts of the sample leaving approximately 15 cm from the edges.

7.2 Procedure

7.2.1 Wash the specimen thoroughly to remove dirt, dust, etc, and cut into small bits. Place them in a weighing bottle. Dry them to constant mass at 105 ± 3°C and determine the oven-dry mass.

7.2.2 Transfer the test specimen from the weighing bottle to a tared silica or porcelain crucible. Heat the crucible slowly and then transfer the crucible along with the contents to a muffle furnace. Ash the contents at 800 to 1 000°C until no glow is visible.

7.2.3 Cool the crucible in a desiccator, weigh and determine the mass of ash.

7.2.4 Calculate the ash content of the specimen by the following formula:

$$\text{Ash content, percent} = \frac{b \times 100}{a}$$

where

b = mass in g of ash (*see* 7.2.3), and

a = oven-dry mass in g of the test specimen (*see* 7.2.1).

8 NON-WOOL CONTENT

8.1 Test Specimens

Draw one test specimen weighing approximately 15 g from each of the test samples selected. The test specimen shall consist of small swatches cut right through the thickness from different parts of the samples leaving approximately 15 cm from the edges.

8.2 Apparatus

8.2.1 *Gooch Crucible*

With sintered filter plate (porosity 150 to 250 microns).

8.3 Reagents

8.3.1 *Caustic Soda Solution,* 5 percent.

8.3.2 *Acetic Acid Solution,* 0.5 percent.

8.4 Procedure

8.4.1 Cut one test specimen into small bits. Dry them to constant mass at 105 ± 3°C and note the oven-dry mass. Boil the bits in caustic soda solution for 20 minutes. Filter through the previously weighed Gooch crucible.

8.4.2 Wash the residue with hot water until free from alkali. Sour with acetic acid solution and finally wash three times with water. Dry the contents by suction.

8.4.3 Dry the Gooch crucible with contents to constant mass at 105 ± 3°C and note the mass of the residue.

8.4.4 Calculate the non-wool content present in the test specimen by the following formula:

$$\text{Non-wool content, percent} = \frac{100 \times b}{a}$$

where

b = mass in g of the residue (*see* 8.4.3), and

a = oven-dry mass in g of the test specimen (*see* 8.4.1).

TEST FOR TYRE YARNS, CORDS AND TYRE CORD WARPSHEETS MADE FROM MAN-MADE FIBRES

LINEAR DENSITY

[*Source* : IS 4910 (Part 2) : 1989]

1 SCOPE

1.1 This standard prescribes a method for determination of linear density of man-made fibre tyre yarns and cords taken from cheeses, cones, bobbins, spools, hanks, or tyre-cord warpsheets.

2 PRINCIPLE

2.1 The mass of a specified length of yarn is determined and linear density is calculated and expressed as denier or tex. The sample is first conditioned and its length is measured.

3 SAMPLING

3.1 Sample from the lot shall be drawn so as to be representative of the lot. Sample drawn in accordance with the relevant material specification or as agreed to between the buyer and the seller shall be held to be representative of the lot.

4 CONDITIONING OF TEST SAMPLE

4.1 Unless otherwise agreed to between the buyer and the seller, the test sample shall be conditioned to a state of moisture equilibrium from the dry side in standard atmosphere at 65 ± 2 percent relative humidity and 27 ± 2°C temperature. A standard temperature of 20 ± 2°C may also be used provided it is declared in the test report.

NOTE — When a test sample under zero tension has been left in such a way as to expose, as far as possible, all portions of it to the standard atmosphere for 24 hours, the test sample shall be deemed to have reached a state of moisture equilibrium.

5 ATMOSPHERIC CONDITIONS FOR TESTING

5.1 The test shall be carried out in the standard atmosphere (*see* 4.1).

6 APPARATUS

6.1 Pan Balance and Weights

The balance shall be of sufficient capacity to weigh the specimen required for the purpose and capable of weighing the specimen to an accuracy of 1 mg.

6.2 Drying Oven

It shall be provided with forced ventilation and capable of maintaining a temperature of 105 ± 3°C, preferably provided with a weighing balance. In case the drying oven is not provided with weighing balance, a desiccator with a suitable desiccant and sealed containers of known mass will also be required.

6.3 Wrap Reel

It shall be capable of winding exact lengths under required tensions.

6.3.1 In case of non-availability of the wrap reel and for yarn or cord taken from warpsheets as alternate device capable of measuring the straightened lengths of yarn shall be used. It shall be provided with two clamps, the distance between which shall be adjustable and through one of which, a known tension could be applied. Each clamp shall consist of two jaws, preferably metallic which have parallel gripping surfaces.

7 PREPARATION OF TEST SPECIMENS

7.1 From each conditioned sample, suitable lengths of yarn or cord subject to a minimum of 9 m shall be reeled off without alteration of twist, keeping a standard pre-tension of 4.4 ± 0.9 mN/tex (0.05 ± 0.01 g/d) so that the mass of each specimen is at least 5 g, discarding a few metres of yarn or cord after taking each specimen. The length shall be measured to an accuracy of 0.1 percent.

NOTE — It is recommended that the lengths be taken in multiples of 10 m (for tex) and 9 m (for denier).

7.1.1 If an apparatus of the type described in 6.3.1 is used, as many straightened lengths under standard pre-tension shall be measured and cut as will make the designed total length and mass stated in 7.1

8 PROCEDURE

8.1 Place the sample in the ventilated drying oven, maintained at 105 ± 3°C and fed with air from standard atmosphere. Continue drying until constant mass is attained. The mass shall be taken as constant when the difference between two successive weighings made at intervals of 20 minutes is less than 0.1 percent. Weighings should be correct to 1 mg.

9 CALCULATIONS

9.1 Calculate the linear density for each specimen by one of the following formulae:

a) $\text{tex} = (100 + R) \times \dfrac{10\,W}{L}$

b) $\text{denier} = (100 + R) \times \dfrac{90\,W}{L}$

where

R = standard moisture regain for the fibre being tested in percentage,

W = oven-dry mass of specimen in g, and

L = length of specimen in m.

NOTE — The standard moisture regain is also sometimes termed as commercial moisture regain in the trade. Unless otherwise agreed to between the buyer and the seller, standard moisture regain value for specified fibres as given below may be used:

Sl No	*Material*	*Standard Moisture Regain, Percent*
i)	Natural cotton yarn	7.0
ii)	Rayon	11.0
iii)	Nylon (polyamide)	4.5
iv)	Polyester	0.4

9.2 Find out the mean of the linear density values, obtained in **9.1**.

10 REPORT

10.1 The report shall include the following information:

a) The type of material;

b) Linear density;

c) Number of tests;

d) Standard moisture regain used, and

e) Temperature used for conditioning, that is, 27 ± 2°C or 20 ± 2°C.

TESTS FOR TYRE YARNS, CORDS AND TYRE CORD WARPSHEETS MADE FROM MAN-MADE FIBRES

LOAD AND ELONGATION CHARACTERISTICS

[*Source:* **IS 4910 (Part 3): 1989**]

1 SCOPE

1.1 This standard prescribes a method for determination of breaking load, elongation at break, load at specified elongation, elongation at specified load and tenacity of man-made fibre tyre yarns and cords taken from cheeses, cones, bobbins, spools, hanks, or tyre-cord warpsheets.

2 SAMPLING

2.1 Sample for the lot shall be drawn so as to be representative of the lot. Sample drawn in accordance with the relevant material specification or as agreed to between the buyer and the seller shall be held to be representative of the lot.

3 CONDITIONING OF TEST SPECIMENS

3.1 Unless otherwise agreed to between the buyer and the seller, the test sample shall be conditioned to a state of moisture equilibrium from the dry side in the standard atmosphere at 65 ± 2 percent relative humidity and 27 ± 2°C temperature. A standard temperature of 20 ± 2°C may also be used provided it is declared in the test report.

NOTE — When a test sample under zero tension has been left in such a way as to expose, as far as possible, all portions of it to the standard atmosphere for 24 hours, the test sample shall be deemed to have reached a state of moisture equilibrium.

3.2 For testing of oven-dry specimens, dry the sample to constant mass by placing it in a drying oven maintained at 105 ± 3°C and fed with air from standard atmosphere.

NOTE — Normally, complete drying of the sample is achieved in 2 hours.

4 ATMOSPHERIC CONDITIONS FOR TESTING

4.1 The test shall be carried out in a standard atmosphere (*see* 3.1).

5 APPARATUS

5.1 Testing Machine

A single strand tensile strength testing machine working on one of the following principles shall be used:

a) Constant-rate-of-load (CRL),

b) Constant-rate-of-traverse (CRT), or

c) Constant-rate-of-extension (CRE).

The specimens shall break within 20 ± 2 seconds in case of constant-rate-of-load and constant-rate-of-extension machines. In case of constant-rate-of-traverse machine, the rate of traverse shall be 300 ± 15 mm/minute and the load range of the machine shall be such that the observed values would be between 10 and 90 percent of the full scale load. The permissible error in the machine at any point in this range shall not exceed ± 1 percent. The machine shall be provided with the following:

a) Two clamps with the following provisions to grip the specimen:

   1) Each clamp of the machine shall be bollard type in which the yarn is gripped between the plain-faced jaws and then makes a half-turn round a cylindrical extension of one of the jaws before passing on to the other similar clamp. The cylindrical friction surface shall be between 10 to 20 mm in diameter. An outline of the above type of clamp is shown in Fig. 1. The length of the specimen between points *A* and *A'* is the test length.

   2) Each clamp shall be provided with a mechanical or pneumatic device so constructed that through its means, a specimen can be secured firmly between the jaws of the clamps so that it does not slip during the test. Also the edge of the surface of each jaws shall be such that it would not cut or damage the specimen during testing.

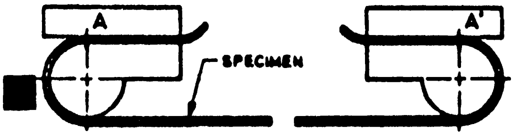


FIG. 1 RECOMMENDED GRIPPING CLAMPS

NOTE — For checking suitability of chosen clamps for testing, samples of various gauge length (namely, 200, 400, 600, 800, 1 000 mm) may be stretched to break and elongation at break plotted against the gauge length to obtain graph as shown in Fig. 2.

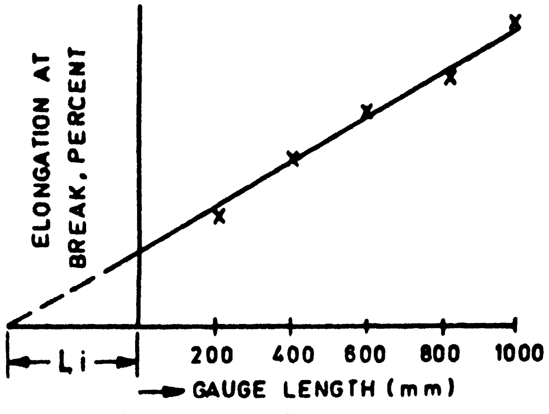


FIG. 2 SELECTION OF SUITABLE CLAMPS

If L_1 exceeds 10 percent of gauge length to be used, the clamps or clamping surfaces are not suitable and may only be used if the parties agree.

b) Means for applying standard pre-tension of 4.4 ± 0.9 mN/tex to the specimen when clamped (the tension device may be dead-weight, a spring, or an air-actuated mechanism).

c) Means for adjusting the distance between the clamps.

d) A scale or dial or autographic chart recorder graduated so as to give load, elongation at pre-determined load/break and load at specified percentage elongation.

5.2 Drying Oven

Provided with forced ventilation and capable of maintaining a temperature of 105 ± 3°C.

6 PROCEDURE

6.1 Test on Conditioned Specimens

6.1.1 Set the clamps of the testing machine so that the distance between the clamps is 250 ± 2 mm, 500 ± 2 mm, or as agreed to between the buyer and the seller. With the help of preliminary specimens, set the machine so that the specimen breaks within 20 ± 2 seconds in case of constant-rate-of-load and constant-rate-of-extension machine and in case the machine is of constant-rate-of-traverse type, set it at a rate of traverse of 300 ± 15 mm/minute. Take the yarn or cord from the conditioned sample and discard a first few metres of yarn or cord. Fix one end in the jaws of one clamp in such a way that the twist does not change. Apply the required pretension from the free end and secure it in the jaws of the other clamp.

6.1.2 Operate the machine and carry the test to rupture and record the breaking load, elongation at pre-determined load as required, elongation at break and load at specified percentage elongation from the load elongation curve of the autographic chart recorder provided.

NOTES

1 If a specimen under test breaks within 1 cm of the point of contact of either jaw, or there is slippage in the jaw, the result should be recorded but not included in the final result. If such breaks exceed 10 percent of the number of specimens tested, overhaul the jaws of the clamps. If necessary, test the specimens with suitable snubbing device, namely, soft leather or paper, though under these conditions, observed values for elongation will not be comparable with those obtained with regular clamps. Give specimens of very low twist multifilament yarns of which more than 10 percent of the specimens breaks in the clamps, a twist of 120 ± 10 turns/metre prior to test for breaking load.

2 When using automated testers in the normal manner, it is usually impossible to cancel the results of defaulted tests. Such results may have a large influence on the final results. To avoid these errors, it is necessary to watch the running test and to correct the test results for any jaw breaks or other defaulted tests. Where the results are read from a digital system and not from the recording chart, the elongation at break is determined at the instant when the measured force has fallen by a predetermined percentage of the full scale value after having passed the minimum value and there will be a systematic deviation in the recorded elongation. The predetermined percentage must be agreed upon between the parties and included in the test report.

If yarn is tested directly from the package in automatic testers, it can result in a different relaxation state of the yarn and the test result may differ from that of a relaxed state.

6.1.3 Open both the clamps and remove the broken specimen. Test another test specimen in a similar manner, discarding at random several metres of yarn between the two successive tests. Perform minimum 20 tests or more as agreed to between the buyer and the seller. In case of sample of yarn or cord from fabrics, a minimum of 20 tests or more as agreed to between the buyer and the seller shall be carried out. The selection of test specimens shall be as agreed to between the buyer and the seller.

6.2 Test on Oven Dry Specimens

6.2.1 Mount the thread without disturbing the twist on a support which would allow the yarn or cord to contract during drying. Put the material in drying oven maintained at 105 ± 3°C (*see* 3.2). Immediately after drying, mount the yarn or cord, under pre-tension, in the clamps of the tensile machine kept in the standard atmosphere near the oven, care should be taken to see that no change in twist occurs while the specimen is being removed from the oven to the testing machine and clamped. Carry the test to rupture as specified in 6.1.1 and 6.1.2.

6.2.2 Maintain the interval from the commencement of loading to the moment of rupture as 20 ± 2 seconds and the interval between the moment at which the test specimen leaves the oven and the moment at which it breaks as 30 ± 2 seconds.

6.2.3 Discard unused portion of yarn or cord outside the oven before mounting a fresh specimen. Perform a minimum of 20 tests or more as agreed to between the buyer and the seller.

7 CALCULATIONS

7.1 Breaking Load

Calculate the mean breaking load in newtons from all the observed values and the coefficient of variation.

7.2 Elongation

Calculate the mean elongation at pre-determined load as required and at break in percent from all the observed values.

7.3 Load at Specified Percentage Elongation

Calculate the mean load at specified percentage elongation in newtons as required.

7.4 Tenacity

Calculate the tenacity by the following formula:

Tenacity, in cN/tex

$$= \frac{\text{Mean breaking load in newtons} \times 100}{\text{Mean linear density in tex}}$$

NOTE — The linear density of yarn or cord shall be determined from the same package in accordance with Part 2 of this standard.

8 REPORT

8.1 The test report shall include the following:

a) Description of the material tested;

b) Name of the instrument and capacity;

c) Mean time for break or rate-of-traverse;

d) The type of test (conditioned or oven dry);

e) Specimen length;

f) Number of tests performed;

g) Mean breaking load and coefficient of variation, if required;

h) Mean elongation at a predetermined load, if required;

j) Mean elongation at break;

k) Mean load at specified percentage elongation if required;

m) Mean tenacity; and

n) Temperature used for conditioning, that is, 27 ± 2°C or 20 ± 2°C.

TEST FOR TYRE YARNS, CORDS AND TYRE CORD WARPSHEETS MADE FROM MAN-MADE FIBRES

DIP PICK-UP

[*Source* : **IS 4910 (Part 4) : 1989**]

1 SCOPE

1.1 This standard prescribes methods for determination of amount of dip on man-made fibre tyre yarns, cords and warpsheets treated with resorcinol formaldehyde latex (RFL) dip solution.

2 PRINCIPLE

2.1 The oven dried dipped material is treated to dissolve pure textile material leaving behind the dip as residue. The residue is oven dried and weighed, and is expressed as the percentage of the oven dry mass of the pure textile material.

3 SAMPLING

3.1 Sample from the lot shall be drawn so as to be representative of the lot. Sample drawn in accordance with the relevant material specification or as agreed to between the buyer and the seller shall be held to be representative of the lot.

4 PREPARATION OF TEST SPECIMEN

4.1 Roll the test sample (weighing about 10 g) under a strong pressure to crush the yarn or cord into a flat ribbon which is more readily penetrated by the reagent. If the crushing apparatus is not available, untwist the yarn into their constituents and cut them into pieces of about 2 mm length with the help of scissors. In either case, take care to see that no material is lost during crushing or cutting. Alternatively, cut the specimen with scissors to 1.6 mm and then crush using mortar and pestle to make it fluffy which would readily dissolve in the reagents.

5 METHOD FOR DIPPED NYLON (POLYAMIDE) TYRE YARNS AND CORDS

5.1 Apparatus and Reagents

5.1.1 *Apparatus*

a) *Drying oven,* provided with forced ventilation and capable of maintaining a temperature of 150 ± 3°C.

b) *Pan balance and weights,* of sufficient capacity to weigh the specimen required for the purpose and capable of weighing the specimen to an accuracy of 1 mg.

c) *Weighing bottles*

d) *Desiccator*

e) *Suction flask and suction device*

f) *Beaker with watch glass cover,* 400 m·

g) *Scissors*

h) *Gooch crucible No. 4*

5.1.2 *Reagents*

a) *Formic acid,* 85 percent (*m/m*)

b) *Acetone*

c) *Methyl orange* (0.1 percent in water)

5.2 Procedure

5.2.1 Identify the fibre that is, nylon (polyamide). Take at least 2 test specimens, each weighing 1 g. Transfer the specimen into a weighing container. Dry the specimen to constant mass in ventilated drying oven, maintained at 150 ± 3°C and fed with air from standard atmosphere. The mass shall be taken as constant when the difference between two successive weighings made at an interval of 20 minutes is less than 0.1 percent.

5.2.2 Determine the mass of the specimen without removing it from the oven with the air flow stopped. In case the drying oven is not provided with the weighing balance, cool the specimen to room temperature in the desiccator and determine its mass correct to 1 mg.

5.2.3 *Dissolving of Textile*

Introduce the test specimen into a 400 ml beaker, taking care to avoid any loss of material. Dissolve the textile material by adding 100 ml of 85 percent formic acid into the beaker. Stir the contents of the beaker with glass stirrer occasionally at room temperature until the textile material is completely dissolved.

5.2.4 Transfer the contents of the beaker as obtained in 5.2.3 to the Gooch crucible No. 4 in portions and filter the solution. Rinse the beaker with three 25 ml portions of formic acid and use this for rinsing the crucible. Continue rinsing with distilled water until neutral reaction to methyl orange is obtained. Finally rinse with 15 ml of acetone.

5.2.5 Dry the residue and crucible at 150 ± 3°C in the drying oven to constant mass and determine the mass of the residue correct to 1 mg.

6 METHOD FOR DIPPED RAYON TYRE YARNS AND CORDS

6.1 Apparatus and Reagents

6.1.1 *Apparatus*

Same as in 5.1.1.

6.1.2 *Reagents*

a) *Formic acid,* 85 percent (*m/m*).

b) *Sulphuric acid,* 98 percent (*m/m*).

c) *Acetone*

d) *Methyl orange* (0.1 percent in water)

6.2 Procedure

6.2.1 Identify the fibre. Take at least 2 test specimens, each weighing about 1 g. Transfer the specimen into a weighing container. Dry the specimen to constant mass in the ventilated drying oven, maintained at 150 ± 3°C and fed with air from standard atmosphere. The mass shall be taken as constant when the difference between two successive weighings made at an interval of 20 minutes is less than 0.1 percent.

6.2.2 Determine the mass of the specimen without removing it from the oven with the air flow stopped. In case the drying oven is not provided with the weighing balance, cool the specimen to room temperature in the desiccator and determine its mass correct to 1 mg.

6.2.3 *Dissolving of Textile*

Introduce the test specimen into a 400 ml beaker, taking care to avoid any loss of material. Dissolve the textile material by adding 100 ml of 85 percent formic acid into the beaker. Stir the contents of beaker with glass stirrer continuously for 20 minutes. Then add 20 ml of 98 percent sulphuric acid. Cover the beaker with a watch glass and stir it occasionally with glass stirrer until textile material is completely dissolved.

6.2.4 Transfer the contents of the beaker as obtained in 6.2.3 in portions to the Gooch crucible No. 4. Rinse the beaker with three 25 ml portions of formic acid and use this for rinsing the crucible. Continue rinsing with distilled water until neutral reaction to methyl orange is obtained. Finally rinse with 50 ml of acetone.

6.2.5 Dry the residue and crucible at 150 ± 3°C in the drying oven to constant mass and determine the mass of the residue correct to 1 mg.

7 METHOD FOR DIPPED POLYESTER TYRE YARNS AND CORDS

7.1 Apparatus and Reagents

7.1.1 *Apparatus*

a) *Erlenmeyer extraction flask*, 250 ml.

b) *Water cooled condenser*

c) *Drying oven*

d) *Pan balance and weights*

e) *Weighing bottles*

f) *Desiccator*

g) *Suction flask and suction device*

h) *Scissors*

j) *Gooch crucible No. 4*

7.1.2 *Reagents*

a) *Methylene chloride*, reagent grade.

b) *Trichloroacetic acid*, reagent grade.

c) *Trichloroacetic acid, methylene chloride solution*, (30 percent m/v). Dissolve 60 g of trichloroacetic acid in 200 ml of methylene chloride.

7.2 Procedure

7.2.1 Identify the fibre. Take at least 2 test specimens, each weighing about 1 g. Transfer the specimen into a weighing container. Dry the specimen to constant mass in ventilated drying oven, maintained at 150 ± 3°C and fed with air from standard atmosphere. The mass shall be taken as constant when the difference between two successive weighings made at an interval of 20 minutes is less than 0.1 percent.

7.2.2 Determine the mass of the specimen without removing it from the oven with the air flow stopped. In case the drying oven is not provided with the weighing balance, cool the specimen to room temperature in the desiccator and determine its mass correct to 1 mg.

7.2.3 *Dissolving of Textile*

Transfer the specimen to the 250 ml Erlenmeyer extraction flask and add 75 ml of trichloroacetic acid-methylene chloride solution. Attach the flask to the condenser and reflux for 15 minutes or until the specimen appears to be dissolved.

7.2.4 When the solution of the specimen is complete, filter the specimen through a Gooch crucible No. 4. Wash the flask and residue on the crucible with three successive 25 ml portions of methylene chloride.

7.2.5 Dry the Gooch crucible with dip solids residue at a temperature of 150 ± 3°C to constant mass. Cool in a desiccator and weigh to the nearest 1 mg.

8 CALCULATION AND REPORT

8.1 Calculate the amount of dip present in the tyre yarn or cord by the following formula:

$$D = \frac{M_r}{M_m - M_r} \times 100$$

where

D = amount of dip in percentage;

M_r = oven dry mass of the residue, in g; and

M_m = oven dry mass of textile material in g.

8.2 The report shall include the following information:

a) Type of material,

b) Number of tests,

c) Amount of dip in percentage, and

d) Method used (*see 6 and 7*)

TESTS FOR TYRE YARNS, CORDS AND TYRE CORD WARPSHEETS MADE FROM MAN-MADE FIBRES

HEAT SHRINKAGE AND HEAT SHRINKAGE FORCE

[*Source:* IS 4910 (Part 5): 1982]

1 SCOPE

1.1 This standard prescribes method for determination of heat shrinkage and heat shrinkage force developed in nylon (polyamide) tyre yarns and cords when exposed to elevated temperature under a standard pre-tension of 4.4 ± 0.9 mN/tex. This standard is applicable to nylon (polyamide) tyre yarns and cords taken from cheeses, cones, bobbins, spools or tyre cord warpsheets. In case of tyre cord warpsheets, the cords shall be removed from the warpsheets for testing.

2 SAMPLING

2.1 Samples from the lot shall be drawn so as to be representative of the lot. Sample drawn in accordance with the procedure laid down in the relevant material specification or as agreed to between the buyer and the seller shall be held to be representative of the lot.

3 CONDITIONING OF TEST SAMPLE

3.1 Unless otherwise agreed to between the buyer and the seller, the test samples shall be conditioned to a state of moisture equilibrium from dry side in standard atmosphere at 65 ± 2 percent relative humidity and 27 ± 2°C temperature. A standard temperature of 20 ± 2°C may also be used provided it is declared in the test report.

NOTE — When a test sample under zero tension has been left in such a way as to expose, as far as possible, all portions of it to the standard atmosphere for 24 hours, the test sample shall be deemed to have reached a state of moisture equilibrium.

4 APPARATUS

4.1 Mounting Device

The device shall be such that a test specimen of at least 250 mm length can be mounted on it with one of its ends in a fixed clamp under desired dead weight tension and exposed to a temperature of 150 ± 2°C, 160 ± 2°C or 175 ± 2°C as the case may be. It shall be provided with means for:

a) measuring the heat shrinkage percentage directly or the initial and final lengths of test specimen to an accuracy of 1 mm during exposure to a high temperature in case of heat shrinkage test, and

b) attaching one clamp to a strain gauge or mechanical device capable of indicating tension to an accuracy of 1 g without any significant changes in the length of the specimen in case of heat shrinkage force test.

5 PROCEDURE

5.1 Mount the conditioned test specimen on the mounting device under a standard pre-tension of 4.4 ± 0.9 mN/tex. Note the original length of the test specimen for heat shrinkage test and initial tension in the case of heat shrinkage force test.

5.2 Expose the test specimen as mounted above to a temperature of 150 ± 2°C, 160 ± 2°C or 175 ± 2°C (as agreed to between the parties) and keep it in this position until change in shrinkage/shrinkage force in the test specimen in 1 minute interval is not more than 5 percent. Note the final length or force, as the case may be, while the specimen is still exposed to higher temperature.

5.3 Take at least 5 readings.

5.4 Calculate the heat shrinkage and heat shrinkage force as follows:

a) Heat shrinkage, percent

$$= \frac{a - b}{a} \times 100$$

where

a = original length of the specimen, and

b = final length of the specimen.

b) Heat shrinkage force in mN/tex

$$= \frac{f_1 - f_2}{t}$$

where

f_1 final tension in mN developed in the specimen,

f_2 = initial tension in mN in the specimen, and

t = linear density of tyre yarn or cord in tex.

6 REPORT

6.1 The report shall include the following information:

a) Type of material;

b) Elevated temperature used;

c) Heat shrinkage;

d) Heat shrinkage force;

e) Number of tests; and

f) Temperature used for conditioning, that is, 27 ± 2°C or 20 ± 2°C.

TESTS FOR TYRE YARNS, CORDS AND TYRE CORD WARPSHEETS MADE FROM MAN-MADE FIBRES

WET CONTRACTION AND WET CONTRACTILE FORCE

[*Source*: **IS 4910 (Part 6) : 1989**]

1 SCOPE

1.1 This standard prescribes method for determination of wet contraction and wet contractile force developed in rayon and nylon (polyamide) tyre yarns and cords when immersed in water at 27 ± 2°C under a standard pretension of 4.4 ± 0.9 mN/tex.

2 SAMPLING

2.1 Samples from the lot shall be drawn so as to be representative of the lot. Sample drawn in accordance with the procedure laid down in the relevant material specification or as agreed to between the buyer and the seller shall be held to be representative of the lot.

3 CONDITIONING OF TEST SAMPLES

3.1 Unless otherwise agreed to between the buyer and the seller, the test sample shall be conditioned to a state of moisture equilibrium from the dry side under standard atmosphere at 65 ± 2 percent relative humidity and 27 ± 2°C temperature. A standard temperature of 20 ± 2°C may also be used provided it is declared in the test report.

NOTE — When the test sample under zero tension has been left in such a way as to expose, as far as possible, all portions of it to the standard atmosphere for 24 hours, the test sample shall be deemed to have reached a state of moisture equilibrium.

4 APPARATUS

4.1 Mounting Device

The device shall be such that a specimen of at least 250 mm length can be mounted on it with one of its ends in a fixed clamp under desired dead-weight tension and immersed in water at 27 ± 2°C. It shall be provided with means for:

a) measuring initial and final lengths of test specimen to an accuracy of 1 mm during immersion, in case of wet contraction test; and

b) attaching one clamp to a strain gauge or a mechanical device capable of indicating tension to an accuracy of 1 g without any significant change in the length of the specimen, in the case of wet contractile force test.

5 PROCEDURE

5.1 Mount the conditioned test specimen on the mounting device under a standard pretension of 4.4 ± 0.9 mN/tex. Note the original length of test specimen for wet contraction test and initial tension in case of wet contractile force test.

NOTE — In case of tyre cord warpsheets, the cords shall be removed from the warpsheets for testing.

5.2 Immerse the test specimen mounted as above in water at 27 ± 2°C temperature and keep it in this position for 5 minutes. Note the final length or force, as the case may be, while the specimen is still under water.

5.3 Take at least 5 readings.

6 CALCULATIONS

6.1 Calculate the wet contraction and wet contractile force as follows:

a) Wet contraction, percent $= \dfrac{a - b}{a} \times 100$

where

a = original length of the specimen, and

b = final length of the specimen,

b) Wet contractile force, mN/tex $= \dfrac{f_1 - f_2}{t}$

where

f_1 = final tension, in mN, developed in the specimen;

f_2 = initial tension, in mN, in the specimen; and

t = linear density of the yarn or cord in tex.

7 REPORT

7.1 The report shall include the following information:

a) Type of material;

b) Wet contraction and wet contractile force;

c) Number of tests; and

d) Temperature used for conditioning the test specimens, that is, 27 ± 2°C or 20 ± 2°C.

TEST FOR TYRE YARNS, CORDS AND TYRE CORD WARPSHEETS MADE FROM MAN-MADE FIBRES

HEAT DEGRADATION

[*Source:* IS 4910 (Part 7) : 1989]

1 SCOPE

1.1 This standard prescribes methods for determination of degradation in strength of rayon and nylon (polyamide) type yarns and cords taken from cheeses, cones, bobbins, spools, hanks, and tyre cord warpsheets after being subjected to elevated temperature.

2 PRINCIPLE

2.1 For Rayon

First, the initial strength of tyre yarn or cord is determined in the oven-dry state. Then the strength of the material is determined after subjecting it to specified elevated temperature for specified time. The loss in strength is determined and expressed as percentage of the initial strength.

2.2 For Nylon (Polyamide)

First, the initial strength of tyre yarn or cord is determined after conditioning it in the standard atmosphere. Then, the strength of the material is determined after subjecting it to specified elevated temperature for specified time and then conditioning it in standard atmosphere. The loss in strength is determined and expressed as a percentage of the initial strength.

3 SAMPLING

3.1 Sample from the lot shall be drawn so as to be representative of the lot. Sample drawn in accordance with the relevant material specification or as agreed to between the buyer and the seller shall be held to be representative of the lot.

4 CONDITIONING OF TEST SPECIMEN

4.1 Unless otherwise agreed to between the buyer and the seller, the test sample shall be conditioned to a state of moisture equilibrium from the dry side in the standard atmosphere at 65 ± 2 percent relative humidity and 27 ± 2°C temperature. A standard temperature of 20 ± 2°C may also be used provided it is declared in the test report.

NOTE — When a test sample under zero tension has been left in such a way as to expose, as far as possible, all portions of it to the standard atmosphere for 24 hours, the test sample shall be deemed to have reached a state of moisture equilibrium.

5 ATMOSPHERIC CONDITIONS FOR TESTING

5.1 The test shall be carried out in the standard atmosphere (*see* 4.1).

6 APPARATUS

6.1 Single Strand Tensile Strength Testing Machine, conforming to 6.1 of Section E/2-2.

6.2 Drying Oven

Drying oven shall be provided with forced ventilation and shall be capable of maintaining temperatures of 105 ± 3°C and 180 ± 3°C.

7 PROCEDURE

7.1 Take a test sample and make skeins out of it. Divide the sample into 2 sets of specimens and follow the procedure as given in 7.1.1 in case of rayon and 7.1.2 in case of nylon (polyamide) tyre yarns and cords.

7.1.1 *Rayon*

Place one set of test specimens in the drying oven maintained at 105 ± 3°C and keep it for 2 hours before testing tensile strength. Place the other set in drying oven maintained at 180 ± 3°C for 4 hours before testing tensile strength. Determine the strength of both sets of specimens of the test sample separately, as given in Section E/2-2.

7.1.2 *Nylon (Polyamide)*

Condition one set of specimens for 24 hours in standard atmosphere before testing tensile strength. Place the other set of specimens in the drying oven maintained at 180 ± 3°C for 4 hours and then condition it in standard atmosphere for 12 hours before testing tensile strength. Determine the strength of both sets of specimens of the test sample separately as given in section E/2-2.

7.2 Test another test specimen in a similar manner. Perform at least 10 tests for both sets of test specimens of the test sample

7.3 Determine the average strength of both sets of the specimens of the test sample separately.

8 CALCULATION

8.1 Calculate the heat degradation of the test sample by the following formula:

$$\text{Heat degradation, percent} = \frac{A - B}{A} \times 100$$

where

A = initial strength of the first set of specimens of the test sample, and

B = final strength of the second set of specimens of the test sample after being subjected to heat treatment.

9 REPORT

9.1 The test report shall include the following:

- a) Description of the material tested;
- b) Name of the instrument and capacity;
- c) Mean time for break or rate of traverse;
- d) Number of tests performed:
    - 1) Initial, and
    - 2) After heat treatment;
- e) Strength:
    - 1) Initial strength, and
    - 2) Strength after heat treatment;
- f) Heat degradation, percent; and
- g) Temperature used for conditioning, that is, 27 ± 2°C or 20 ± 2°C.

TEST FOR TYRE YARNS, CORDS AND TYRE CORD WARPSHEETS MADE FROM MAN-MADE FIBRES

THICKNESS

[*Source*: **IS 4910 (Part 8) : 1989**]

1 SCOPE

1.1 This standard prescribes a method for determination of thickness (gauge) of man-made fibre tyre cords taken from cheeses, cones, bobbins, spools, or tyre cord warpsheets.

2 PRINCIPLE

2.1 The average thickness of a group of parallel tyre cords resting on an anvil is determined when a specified pressure is applied by the presser foot of a thickness gauge.

3 SAMPLING

3.1 Sample from the lot shall be drawn so as to be representative of the lot. Sample drawn in accordance with the relevant material specification or as agreed to between the buyer and the seller shall be held to be representative of the lot.

4 ATMOSPHERIC CONDITIONS FOR CONDITIONING AND TESTING

4.1 Unless otherwise agreed to between the buyer and the seller, the test sample shall be conditioned to a state of moisture equilibrium from the dry side in the standard atmosphere at 65 ± 2 percent relative humidity and 27 ± 2°C temperature. A standard temperature of 20 ± 2°C may also be used provided it is declared in the test report.

NOTE — When a test sample under zero tension has been left in such a way as to expose, as far as possible, all portions of it to the standard atmosphere for 24 hours, the test sample shall be deemed to have reached a state of moisture equilibrium.

4.2 The test shall be carried out in the standard atmosphere.

5 APPARATUS

5.1 Thickness Gauge Tester

The instrument used for measuring thickness of tyre cords shall be provided with the following arrangements:

a) A circular presser foot of 9.5 mm diameter;

b) A circular anvil having diameter at least 10 mm larger than that of the presser foot;

c) Means to apply pressure of 24 mN/mm^2 to the specimens;

d) A dial or gauge graduated in mm and capable of reading to an accuracy of 0.01 mm; and

e) Means for adjusting zero reading on the dial.

NOTE — Any other apparatus capable of applying the same pressure of 24 mN/mm^2 may also be used.

5.1.1 The presser foot and the anvil surfaces shall be plain and parallel to each other within 0.001 mm and the movement of the presser foot relative to the anvil shall be at right angles to the surfaces of the parallel plates.

6 PROCEDURE

6.1 Take a specimen composed of four cords from the sample and handle the cords in such a manner that no change of twist can occur.

6.1.1 For tabby samples of tyre cord warpsheet prior to removing each set of four cords, position the cords such that they are adjacent and parallel with no ends crossed.

6.1.2 Grasp the four cords so that the length of the cords between the finger tips of the left hand and the right hand is approximately equal to the length of the anvil.

6.1.3 Inspect the top and bottom of the specimen to be sure that no knots/splices/foreign protuberances are present on the length of the cords to be gauged.

6.1.4 Place the four cords side by side on the anvil and directly under the presser foot of the thickness gauge.

6.1.5 Apply sufficient tension to make the cords straight. Lower the presser foot gradually and gently. Wait until gauge reading becomes stable and record the thickness of the specimen.

6.2 Similarly take at least four more readings from other test samples, find the average of all the readings and report it as thickness (gauge) of the tyre cord correct to 0.01 mm.

7 REPORT

7.1 The report shall include the following information:

a) Type of material tested,

b) Diameter of presser foot,

c) Pressure applied,

d) Number of readings taken,

e) Thickness (gauge), and

f) Temperature used for conditioning, that is, 27 ± 2°C or 20 ± 2°C.

TEST FOR TYRE YARNS, CORDS AND TYRE CORD WARPSHEETS MADE FROM MAN-MADE FIBRES

CREEP

[*Source*: **IS 4910 (Part 10) : 1989**]

1 SCOPE

1.1 This standard prescribes a method for measuring creep (change in length) of tyre cords taken from cheeses, cones, bobbins, spools or tyre cord warpsheets under a specified load.

2 PRINCIPLE

2.1 The initial length of conditioned test specimen is determined after putting the specified load for 60 seconds. After 30 minutes, the length is measured again and taken as the final length.

3 SAMPLING

3.1 Sample from the lot shall be drawn so as to be representative of the lot. Sample drawn in accordance with the relevant material specification or as agreed to between the buyer and the seller shall be held to be representative of the lot.

4 CONDITIONING OF TEST SAMPLE

4.1 Unless otherwise agreed to between the buyer and the seller, the test sample shall be conditioned to a state of moisture equilibrium from the dry side in standard atmosphere at 65 ± 2 percent relative humidity and 27 ± 2°C temperature. A standard temperature of 20 ± 2°C may also be used provided it is declared in the test report.

NOTE — When a test sample under zero tension has been left in such a way as to expose, as far as possible, all portions of it to the standard atmosphere for 24 hours, the test sample shall be deemed to have reached a state of moisture equilibrium.

5 APPARATUS

5.1 Mounting Device

The device shall be such that a test specimen of at least 250 mm length can be mounted on it with one of its ends in a fixed clamp. It shall be provided with means for:

a) attaching desired tension weights to the free end of the specimen in such a manner that there is no change in twist, and

b) measuring the initial and final lengths of the test specimen to an accuracy of 1 mm while under test.

6 PROCEDURE

6.1 Fix one end of the conditioned test specimen in the fixed clamp of the apparatus and apply a standard pre-tension of 4.4 ± 0.9 mN/tex by attaching weights to the free end in such a manner that there is no change in twist. Note the initial length of the test specimen.

6.2 Add additional weights to the free end of the specimen so that the total tension on the specimen is equal to 8.8 ± 0.9 mN/tex or any other load agreed to between the buyer and the manufacturer. Note the initial length of the specimen after 20 seconds. Observe the increase in length after a time interval of 30 seconds up to 30 minutes or any other pre-determined time as agreed to between the buyer and the manufacturer. Note the final length of the test specimen after 30 minutes or any other predetermined time.

NOTE — Creep testing can also be done with the help of a tensile tester having the facility to hold the specimen at a constant load. This can be observed as the percent change in length of sample from the time it reaches the specified load up to 30 minutes or any other predetermined time at the same load or as agreed to between the buyer and the manufacturer under specified atmospheric conditions. This test can also be performed at high temperatures in a standard atmosphere temperature cabinet which can be mounted on the tensile tester.

6.3 Take at least 5 readings and find out the average of all readings.

7 CALCULATION

7.1 Calculate the percentage creep of each test specimen as follows:

$$\text{Creep, percent} = \frac{b - a}{a} \times 100$$

where

a = initial length of the specimen, and

b = final length of the specimen.

8 REPORT

8.1 The report shall include the following information:

a) Type of the material;

b) Creep, percent;

c) Number of tests; and

d) Temperature used for conditioning, that is, 27 ± 2°C and 20 ± 2°C.

TEST FOR TYRE YARNS, CORDS AND TYRE CORD WARPSHEETS MADE FROM MAN-MADE FIBRES

COMMERCIAL MASS

[*Source* : **IS 4910 (Part 11) : 1989**]

1 SCOPE

1.1 This standard prescribes methods for determination of commercial mass of consignments of man-made fibres, tyre yarns, cords and tyre cord warpsheets.

1.1.1 This standard is applicable to dipped as well as undipped material.

2 PRINCIPLE

2.1 The commercial mass is obtained by adding a mass corresponding to commercial moisture regain to the oven-dry mass of the consignment which is determined by testing a representative sample of the material in the consignment.

3 SAMPLING

3.1 Sample from the lot shall be drawn so as to be representative of the lot. Sample drawn in accordance with the relevant material specification or as agreed to between the buyer and the seller shall be held to be representative of the lot.

4 METHODS

4.1 This standard covers two methods for determination of commercial mass of consignments of:

a) packages with single thread, and

b) warpsheet in rolls.

5 METHOD A – PACKAGES WITH SINGLE THREAD

5.1 Place immediately the selected yarn or cord package with its support package and packing material in an air-tight tared vessel and determine its mass. Afterwards determine the net mass (Wn) of the material in each yarn or cord package by deducting the mass of the tared vessel, packing material and support of package used.

NOTE – In case of large packages weighing 1.5 kg or more, the method given in Annex A may be followed if agreed to between the concerned parties.

5.2 Cut the material (yarn or cord) from the package and determine its oven-dry mass (W_0).

5.3 In case of dipped material, the amount of dip present in the material shall be determined as given in section E/2-3.

5.4 Determine the net mass (W_c) of material (yarn of cord) of each sampled container (box) by deducting the mass of the packing material and the corresponding mass of supports of packages, etc, from the total mass. The total mass of package represents the mass of the support packages, packing material, the yarn or cord material and the container in which the packages are packed.

5.5 Calculate the commercial mass in kg of each sampled container by the following formula:

$$\text{Commercial mass of the material of sampled container} = \frac{100 + R}{100} \times \frac{W_o}{W_n} \times W_c$$

where

R = commercial moisture regain, percent (*see* Notes 1 and 2);

W_o = oven-dry mass of the material in the package (*see* 5.2);

W_n = net mass of the material in (sampled) package (*see* 5.1); and

W_c = net mass of the material of the sampled container (box).

NOTES- 1 Unless otherwise agreed to between the buyer and the seller, the standard moisture regain values for specified fibres are given below:

Sl No.	*Material*	*Commercial Moisture Regain, Percent*
i)	Natural cotton yarn	7.0
ii)	Rayon	11.0
iii)	Nylon (Polyamide)	4.5
iv)	Polyester	0.4

2 The standard moisture regain is also sometimes termed as commercial moisture regain in the trade.

5.6 Determine the commercial mass of the consignment by the following formula:

$$\text{Commercial mass of consignment} = \text{Invoice mass of consignment} \times \frac{\text{Commercial mass of material of the sampled container}}{\text{Invoice mass of the material of the sampled container}}$$

6 METHOD B – WARPSHEET IN ROLLS

6.1 Cut the test pieces provided at the end of the sampled warpsheet rolls in full width for the purpose of testing. Determine its length. Also determine the oven-dry mass of warp, W_1, and weft, W_2, in test specimen separately.

6.2 Determine the full length of the fabric piece L.

6.3 In case of dipped material, the amount of dip present in the material shall be determined as given in Section E/2-3.

6.4 Calculation

Calculate the commercial mass in kg of the sampled warpsheet roll by the following formula:

$$\text{Commercial mass of sampled warpsheet roll} = \frac{100 + R_1}{100 \times 1\,000} \times \frac{L}{l} \times W_1$$

$$= \frac{100 + R_2}{100 \times 1\,000} \times \frac{L}{l} \times W_2$$

where

R_1 and R_2 = Commercial moisture regains for warp and weft threads respectively (*see* Notes 1 and 2 under **5.5**),

L = length of the fabric in m,

l = length of test piece in m,

W_1 = oven-dry mass of warp yarn in the test specimen in g, and

W_2 = oven-dry mass of corresponding weft yarn in the test specimen in g.

6.5 Determine the commercial mass of the consignment by the following formula:

$$\text{Commercial mass of consignment} = \text{Invoice mass of consignment} \times \frac{\text{Commercial mass of sampled warpsheet rolls}}{\text{Invoice mass of sampled warpsheet rolls}}$$

7 REPORT

7.1 The report shall include the following:

a) Type of the material,

b) Invoice mass of the consignment,

c) Commercial mass of the consignment,

d) Standard moisture regain value used, and

e) Dip allowance value used.

ANNEX A

(*Clause* 5.1, *Note*)

SPECIAL METHOD OF DETERMINING THE COMMERCIAL MASS OF LARGE PACKAGES

A-1 PRINCIPLE

A-1.1 This method is based on the measurement of total length of yarn on the package and on the determination of oven-dry mass of the yarn per unit length.

A-1.1.1 Under well defined conditions, the oven-dry mass of the whole package can be deduced.

A-2 APPARATUS

A-2.1 The apparatus shall consist of a winding frame fitted with a device enabling the length of yarn wound-on to be measured to within about one percent.

A-2.2 Winding Frame

The winding frame shall have a speed not greater than 200 m/min. The unwinding tension shall be maintained in the range of 5 ± 1 mN/tex.

A-2.3 Length Measuring Device

This device consists of a measuring roller *A* of uniform diameter (not less than 100 mm of hard, smooth material) on the shaft of which is mounted a revolution counter as shown in Fig. 1. A roller of soft material *B* presses against the measuring roller. The load applied to the pressure roller shall not be less than 100 g/cm of the line of contact between the two rollers. Check the surface of the measuring roller at frequent intervals to ensure that it is in good condition.

A-2.3.1 Check to ensure that there is no slippage:

a) by testing the accuracy of the readings given by the revolution counter after repeated winding of the same piece of yarn. Some discrepancies may

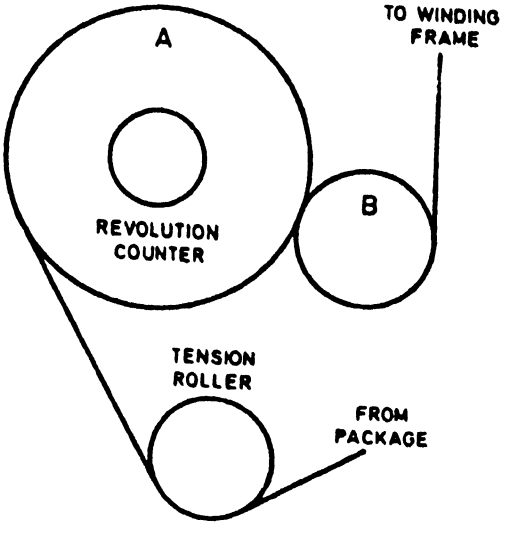


FIG. 1 LENGTH MEASURING DEVICE

arise from the possible crushing of the yarn between the rollers or from change in twist during repeated winding off. These discrepancies may be tolerated provided they do not exceed 0.05 percent for each rewind, and

b) by comparing the readings given by the length measuring device with those given by an accurate, carefully calibrated wrap reel.

A-3 PACKAGE SAMPLING SCHEME

A-3.1 While the yarn is being unwound from the package, take known lengths l_2, l_3, l_4 and l_5, accurate to within 0.1 percent, corresponding to a mass of about 40 g at four points equally distributed throughout the package as shown in Fig. 2.

A-3.2 Apart from these four samples, take two similar samples from the two ends of the package of known lengths l_1 and l_6.

A-3.3 At the same time, note the lengths L_1, L_2, L_3, L_4 and L_5 of yarn wound off between each sampling.

In this manner six samples are obtained from which the finish shall be removed before they are dried and weighed in the oven-dry state.

A-4 CALCULATIONS

A-4.1 Oven-Dry Mass of Package

A-4.1.1 Determine the oven-dry mass per unit length Al_j, for each sample as follows:

$$Al_j = \frac{A_j}{l_j}$$

where

j = 1, 2..........6;

A_j = oven-dry mass of the jth sample; and

l_j = corresponding length measured on the winding frame.

A-4.1.2 Determine the oven-dry mass AL_1, Al_2.....AL_5 of the lengths L_1, L_2.....L_5, respectively of the package as follows:

$$AL_1 = L_1 \frac{Al_1 + Al_2}{2}$$

$$AL_2 = L_2 \frac{Al_2 + Al_3}{2}$$

....

....

$$AL_5 = L_5 \frac{Al_5 + Al_6}{2}$$

A-4.1.3 Determine the oven-dry mass of the complete package as follows:

$$A_j = \sum_{j=1}^{6} A_j + \sum_{j=1}^{5} AL_j$$

A-4.2 Commercial Mass of Package

Determine the commercial mass of the sampled package as follows:

$$\text{Commercial mass of the material of the sample package} = A_j \times \frac{100 + R}{100}$$

where

A_j = oven-dry mass of the material of the sampled package (*see* A-4.1.3), and

R = commercial moisture regain value used (*see* Notes 1 and 2 under **5.5**).

A-4.3 Commercial Mass of Consignment

Determine the commercial mass of the consignment by the following formula:

$$\text{Commercial mass of consignment} = \text{Invoice mass of consignment} \times \frac{\text{Commercial mass of sampled package}}{\text{Invoice mass of sampled package}}$$

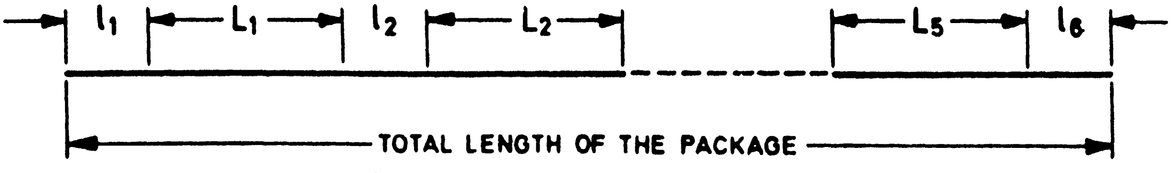


FIG. 2 ARRANGEMENT OF YARN LENGTHS

TEST FOR JUTE NEEDLE LOOM FELTS —DETERMINATION OF THICKNESS

(*Source* : IS 10055 : 1982)

1 SCOPE

This standard prescribes a method for test of determination of thickness of needle loom felts.

2 ATMOSPHERIC CONDITIONS FOR CONDITIONING AND TESTING

2.1 The tests shall be carried out in the standard atmosphere at 27 ± 2 °C temperature and 65 ± 2 percent relative humidity.

2.2 Prior to test, the specimens shall be conditioned to moisture equilibrium in the standard atmosphere. When the specimens have been left in such an atmosphere for 48 hours in such a way as to expose as far as possible all portions of the specimens to the atmosphere, they shall be deemed to have reached moisture equilibrium.

NOTE — Thickness measurements may also be carried out in the prevailing atmosphere after attaining moisture equilibrium. But, in case of dispute, conditioning of the test specimen is recommended.

3 THICKNESS

3.1 Test Specimen

Each roll in the test sample selected shall constitute a test specimen.

3.2 Apparatus

3.2.1 Micrometer gauge provided with a dial gauge reading to 0.25 mm or less having a separate or detachable foot of 10 cm diameter.

3.2.1.1 The gauge shall be capable to provide a pressure of 21 kPa on the test specimen.

NOTE — 1 Kilopascal (kPa) is approximately equal to 10 gf/cm^2.

3.3 Procedure

3.3.1 Clean the surfaces of the presser foot and anvil. Adjust the gauge so that it provides the requisite pressure (*see* 3.2.1.1) on the specimen during the test. Set the gauge to read zero when the presser foot rests on the anvil.

3.3.2 Raise the presser foot and lay a portion of the specimen on the anvil and render it free from wrinkles and creases with no greater tension than is necessary to make it lie flat and straight. Lower the presser foot slowly avoiding jerks or impacts till the requisite pressure (*see* 3.2.1.1) is applied on the felt. Read the dial immediately after the visible movement of the pointer ceases.

3.3.3 Measure the thickness of the specimen under test at 5 different places across the diagonal and record the values. Find the average of all the readings of each test specimen.

SECTION F

TESTS FOR FISHING GEAR MATERIALS

TEST FOR FISHING GEAR MATERIALS DETERMINATION OF THICKNESS

[*Source* : IS 5815 (Part 1) : 1971]

1 SCOPE

1.1 This standard prescribes the method for determination of thickness of netting yarns defined as the distance between one surface and its opposite; and in textiles, the distance between upper and lower surfaces, excluding the standing-out hairs.

2 PRINCIPLE

2.1 Thickness is usually determined as the distance between the two edges of the cord measured on a travelling microscope or a projector. The value is read off from the projected image.

3 CONDITIONING OF TEST SPECIMEN

3.1 Conditioning of Test Sample

The test samples shall be conditioned to a state of moisture equilibrium from dry side in standard atmosphere at 65 ± 2 percent relative humidity and 27 ± 2 °C temperature.

3.1.1 When a test sample under zero tension has been left in such a way as to expose as far as possible, all portions of it to the standard atmosphere for 24 hours, the test sample shall be deemed to have reached a state of equilibrium.

4 ATMOSPHERIC CONDITIONS FOR TESTING

4.1 The test shall be carried out in the standard atmosphere (*see* **3.1**).

5 NUMBER OF TESTS

5.1 Ten tests shall be taken from 10 sample cords, selected at random from a minimum of 5 packages.

6 APPARATUS

6.1 Any yarn thickness projector is suitable; an example of this would be a projection microscope.

7 PROCEDURE

7.1 Mount the cord on the projector and focus it until a clear image is obtained on the screen bearing the scale. Adjust the position of the scale so that zero coincides with the lower image of the cord. Note the reading on the upper edge to the nearest 0.01 mm, ignoring any fibres protruding on the surface of the cord.

8 CALCULATION OF RESULTS AND REPORT

8.1 Calculate the mean of the readings to an accuracy of 0.01 mm.

8.2 Report the following:

a) Description of the material,

b) Name of the instrument,

c) Number of tests taken, and

d) Average thickness.

TEST FOR FISHING GEAR MATERIALS DETERMINATION OF LINEAR DENSITY (MASS PER UNIT LENGTH)

[*Source*: IS 5815 (Part 2) : 1970]

1 SCOPE

1.1 This standard prescribes the method for determination of linear density (mass per unit length) of netting yarns, dry, wet and under water.

2 PRINCIPLE

2.1 The linear density is calculated from the length and the mass of suitable specimens. The sample is first conditioned free from tension and length is measured under standard pre-tension. The specimens are then weighed in the required condition (dry, wet or immersed in water to calculate the mass in sea water).

3 CONDITIONING OF TEST SPECIMEN

3.1 Conditioning for Test in Dry State

The test sample shall be conditioned to a state of moisture equilibrium from dry side in standard atmosphere at 65 ± 2 percent relative humidity and 27 ± 2°C temperature.

3.1.1 When a test sample under zero tension has been left in such a way as to expose as far as possible, all portions of it to the standard atmosphere for 24 hours, the test sample shall be deemed to have reached a state of equilibrium.

3.2 Testing in Wet State

The test specimens, after cutting to standard length under standard pre-tension (*see* 7.1 and 7.1.1) shall be immersed in tap water at room temperature without wetting agent for a period of not less than 12 hours.

3.2.1 A shorter time of immersion (one hour) may be used with the addition of wetting agents.

4 ATMOSPHERIC CONDITIONS FOR TESTING

4.1 The tests shall be carried out in the standard atmosphere (*see* 3.1).

5 NUMBER OF TESTS

5.1 The results shall be based on the average of 10 tests.

6 APPARATUS

6.1 Pan Balance and Weights

Of sufficient capacity to weigh the specimen required for the purpose and capable of weighing the specimen to an accuracy of 10 mg.

6.2 Wrap Reel

Capable of winding exact lengths under required tensions.

6.2.1 In case of non-availability of wrap reels and in case twines are available in short lengths or for twines removed from nets, an alternate device capable of measuring the straightened lengths of twine shall be used. It shall be provided with two clamps, the distance between which shall be adjustable and through one of which a known tension could be applied. Each clamp shall consist of two jaws, preferably metallic, having parallel gripping surfaces. The gripping surfaces shall be in the same plane.

7 PREPARATION OF TEST SPECIMENS

7.1 From each conditioned sample, suitable lengths of twine shall be reeled off without alternation of twist keeping the standard pre-tension of tex/2 g so that the weight of each specimen is at least 5 g. The length of the specimen shall be determined to within 0.1 percent while under the specified pre-tension.

The length of each test specimen shall be of 10 metres (for tex) and 9 metres (for denier) or its multiples.

7.1.1 In the case of short lengths, if an apparatus of the type described in 6.2.1 is used, as many straightened lengths under standard pre-tension of 0.45 ± 0.09 g/tex (or 0.05 ± 0.01 g/d) shall be measured and cut as will make up the desired total length and weight given in 7.1.

8 PROCEDURE

8.1 Dry Mass

Specimens prepared according to 7.1 or 7.1.1 shall be weighed correct to 1 mg.

8.2 Wet Mass

Specimens prepared according to 7.1 or 7.1.1 and immersed in water in accordance with 3.2 shall be removed from water allowed to drain and weighed.

8.3 Mass Under Water

Specimen weighed according to 8.1 is completely soaked in water for 12 hours. It is then weighed, suspended in water at room temperature. For materials lighter than water, a sinker is used. The values shall then have a negative sign.

9 CALCULATIONS

9.1 Calculate the linear density of each specimen by using the following formulae:

a) $\text{tex} = \dfrac{1\,000\,M}{L}$

b) $\text{Denier} = \dfrac{9\,000\,M}{L}$

where

M = mass of the specimen in g, and

L = length of specimen in metres.

9.2 The wet-mass is expressed as a percentage of the dry-mass.

9.3 The mass of the specimen under water is expressed as a percentage of the mass of the air-dry mass.

9.4 Specific gravity

$$\text{Specific gravity} = \frac{0.998}{1 - \left(\dfrac{\text{Mass in water}}{\text{Air dry mass}}\right)}$$

9.5 Mass in sea water,

$$\text{percent} = 100 \times \left(1 - \frac{\text{sp gr of sea water}}{\text{sp gr of material}}\right)$$

TEST FOR FISHING GEAR MATERIALS DETERMINATION OF TWIST

[*Source*: **IS 5815 (Part 3) : 1970**]

1 SCOPE

1.1 This standard prescribes the method for determination of twist in terms of turns per unit length and the direction of single, ply and cable twist in fish net yarns.

2 PRINCIPLE

2.1 The twist in a known length of yarn is removed by rotating one end of the specimen in respect to the other until the elements being tested are parallel. The exact number of turns required to remove the twist is reported in terms of turns per unit length.

3 ATMOSPHERIC CONDITIONS FOR TESTING

3.1 The tests shall be carried out in a standard atmosphere (*see* 3.2).

3.2 Conditioning of Test Specimen

The test specimen shall be conditioned to a state of moisture equilibrium from dry side in standard atmosphere at 65 ± 2 percent relative humidity and 27 ± 2°C temperature.

4 APPARATUS

4.1 The twist tester shall consist of a pair of clamps; one of them shall be such that it is capable of being rotated in either direction, and shall be positively connected to a revolution counter capable of recording with an accuracy of one-tenth of a turn and the other shall be such that it is not capable of rotation but it is possible to slide it so that the distance between the clamps becomes adjustable. The tester shall be such that the prescribed tension may be applied to the specimen under test.

5 PROCEDURE

5.1 Determination of Twist in Cabled Yarn

Set the sliding clamp 25 cm away from the rotating clamp. Set the revolution counter to zero. Mount one test specimen in the clamps (taking care not to allow any twist to run out), straightening out by applying a tension equal to tex/2.

Revolve the rotating clamp to untwist the specimen until it is possible to pass a needle, from one clamp to the other, between the strands of the component plied yarn. Note and record the reading on the revolution counter. Cut off all but one component strands of plied yarn near the jaws of the clamps and remove them. Test the component strand of plied yarn (still in the clamps) for twist as detailed in 5.2.

5.1.1 Test similarly the remaining test specimens of cabled yarn for twist and record the test values.

5.2 Determination of Twist in Plied Yarn

Set the sliding clamp 25 cm away from the rotating clamp. Set the revolution counter to zero. Mount one test specimen in the clamp (taking care not to allow any twist to run out), straightening it out by applying a tension equal to tex/2.

Revolve the rotating clamp to untwist the specimen until it is possible to pass a needle from one clamp to the other, between the strands of the component single yarn. Note and record the reading on the revolution counter. Cut off all but one component strand of single yarn near the jaws of the clamps and remove them. Test the component strand (still in the clamps) for twist as detailed in 5.3.

5.2.1 Test similarly the remaining test specimens of plied yarn and record the test values.

5.3 Determination of Twist in Single Yarn

Set the sliding clamp 25 cm away from the rotating clamp. Set the revolution counter to zero. Mount one test specimen in the clamps (taking care not to allow any twist to run out), straightening it out by applying a tension equal to tex/2.

Revolve the rotating clamp to untwist the specimen until it is possible to pass a needle, from one clamp to the other, between the untwisted fibres of the specimen. Note and record the reading on the revolution counter.

5.3.1 Test the remaining test specimens similarly and record the test results.

5.4 Note the reading on the revolution counter correct to two places of decimal and record it.

5.5 Direction of Twist

If required, the direction of twist in single, plied and cabled yarns and the components of the latter two shall also be visually determined and reported along with the results.

5.6 Test Specimens

For single, plied and cabled yarns the minimum number of test specimens to be chosen shall be 10.

6 RESULTS

6.1 The mean of the values obtained on testing all the test specimens of cabled yarn, plied yarn and single yarn shall form the basis of the report of the results. The mean value shall be reported as turns per metre rounded off to the nearest integer.

6.2 When required, report also the change in length on untwisting, calculated as a percentage of the length before twisting as twist take-up.

TESTS FOR FISHING GEAR MATERIALS DETERMINATION OF BREAKING LOAD AND KNOT BREAKING LOAD

[*Source* : **IS 5815 (Part 4) : 1971**]

1 SCOPE

1.1 This standard prescribes the method for determination of breaking load and knot breaking load of netting yarns, determined both in the dry and wet state. Tests in the wet state on the knotted yarn are considered to be particularly appropriate in indicating the behaviour of the yarn in use.

2 DEFINITIONS

2.0 For the purpose of this standard, the following definitions shall apply.

2.1 Breaking Load (*P Max*)

The breaking load, equal to the maximum load observed during a breaking test shall be as follows:

a) The dry yarn breaking load (*P Max d*),

b) The wet yarn breaking load (*P Max w*),

c) The dry knot breaking load (*P Max kd*), and

d) The wet knot breaking load (*P Max kw*).

2.2 Load at Rupture

The final load at the moment that the specimen (or the first component of the specimen) breaks at or after the breaking load has been reached. The load at rupture is usually, but not always, identical with the breaking load.

2.3 Tenacity

The breaking load (*P Max d, P Max w, P Max kd, P Max kw*) per unit resultant linear density of the unstrained specimen in the conditioned state expressed in grams force per tex.

2.4 Breaking Length

The calculated length of a specimen whose conditioned weight exercises a force equal to its breaking load (*P Max d* or *P Max kd*). It is expressed in kilometres and is numerically equal to the tenacity.

2.5 Time-to-Break

The time in seconds, taken to reach the breaking load measured from the moment of application of the load.

3 PRINCIPLE

3.1 A length of yarn is extended in dry or wet state until it reaches the load at rupture by a suitable apparatus, that records or indicates the applied load.

4 CONDITIONING OF TEST SPECIMENS

4.1 Testing in the Dry State

The test sample to be tested in the dry state shall be conditioned to a state of moisture equilibrium from dry side in standard atmosphere at 65 ± 2 percent relative humidity and 27 ± 2°C temperature.

4.1.1 When a test sample under the above conditions has been left in such a way as to expose, as far as possible, all its portions to the standard atmosphere for 24 hours, the test sample shall be deemed to have reached the state of moisture equilibrium.

4.2 Testing in the Wet State

All specimens to be tested in the wet state shall be immersed in tap water without wetting agents at room temperature for a period of not less than 12 hours. Surplus water shall then be shaken off.

4.2.1 A shorter time of immersion (one hour) may be used with the addition of wetting agents.

5 ATMOSPHERIC CONDITIONS FOR TESTING

5.1 The test shall be carried out in the standard atmosphere or where it is not possible to carry out the test in the standard atmosphere, they shall be carried out immediately after the removal of the sample from the standard atmosphere.

6 NUMBER OF TESTS

6.1 At least 20 single valid tests for each sample package shall be carried out. If a distinct confidence interval for the main values is prescribed, as many additional tests shall be carried out as necessary to secure that interval.

7 APPARATUS

7.1 Tensile Testing Machine

Tensile testing machines shall be of any one of the following types:

a) Constant rate of elongation,

b) Constant rate of load, and

c) Constant rate of traverse.

7.1.1 All tensile testing machines shall include a pair of suitable devices to hold the specimen, a means of holding or elongating the specimen at suitable rates, and a load indicating mechanism which will indicate or record continuously the load applied to the specimen.

7.1.2 The maximum error of the indicated load at any point in the range in which the machine is used shall not exceed ± 1 percent. The accuracy of the graduated scale of the apparatus shall be checked dynamically, for example, by means of calibrated springs of appropriate characteristics.

7.1.3 The testing machine shall be capable of testing specimens having a nominal gauge length of 250 mm.

7.1.4 The testing machine shall include facilities for producing different rates of loading in order to break specimens in the specified average time-to-break.

7.2 Suitable Equipment

In which specimens can be immersed in water preparatory to wet testing.

8 PREPARATION OF TEST SPECIMENS

8.1 The specimens shall be removed from the package before exposure to the standard atmosphere or before immersing in water in such a manner that there is no alteration in the twist.

9 PROCEDURE

9.1 Ensure that the distance between the loading devices is at least 250 mm. Mount the specimen in the testing machine so that axis of the specimen is parallel and coincidental to the direction of the applied force. Apply the force to reach the prescribed mean time to break. Discard all such observations in which the specimens slip between the loading device or break due to damage caused by the loading device. The number of observations discarded as above shall be noted. Note also whether any component yarn breaks before breaking load is reached. In the case of testing in wet state, the sample shall be tested immediately after removal from the water.

9.2 Testing of Knotted Netting Yarns in Dry and Wet State

9.2.1 All knots shall be made immediately before testing and gently tightened by hand. Precautions shall be taken to ensure that the twist is not altered.

9.2.2 The specimens shall be tested with the weaver's knot. All four ends of the weaver's knot shall be fastened in the holding devices. Each load device holds two ends of the same yarn of approximately the same length (*see* Fig. 1).

NOTE — Alternately, over-hand knot may be made in a twine with the direction of knotting opposite to the direction of twisting of twine and the knot may be tested for breaking load.

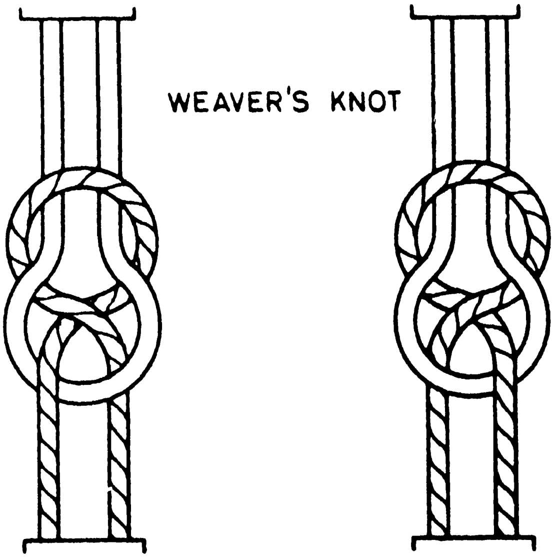


FIG. 1 WEAVER'S KNOT

9.2.3 If the test specimen does not break at the knot, the test shall be discarded.

10 CALCULATION AND EXPRESSION OF RESULTS

10.1 Average Breaking Load

Average breaking load ($P\ Max$)

$$\text{in kilogram force}^{*} = \frac{\Sigma P\ Max}{n}$$

where

$\Sigma P\ Max$ = the sum of the observed value of breaking loads, expressed in kilogram force; and

n = the number of observations.

Calculate the average breaking load to 4 significant figures and round it off to 3 significant figures.

10.2 Tenacity

$$\text{Average tenacity in gram force}^{\dagger}\text{ per tex} = \frac{P\ Max}{Tt}$$

where

$P\ Max$ = the average breaking load (*see* **10.1**, but expressed in gram force); and

Tt = the average resultant linear density of the conditioned sample expressed in tex.

Calculate the average tenacity to 4 significant figures and round it off to 3 significant figures.

10.3 Breaking Length

$$\text{Breaking length in kilometres} = \frac{P\ Max}{Tt}$$

where

$P\ Max'$ = the average breaking load, expressed in kilogram force (*see* **10.1**); and

Tt = the average resultant linear density of the conditioned sample expressed in kilotex.

Calculate the average breaking length to 4 significant figures and round it off to 3 significant figures.

10.4 If necessary, the coefficient of variation and the confidence interval may be calculated by recognized statistical methods.

11 REPORT

11.1 The report shall state that the tests were performed in accordance with this Indian Standard. The date of the test and the following shall be stated:

a) Type, size and direction of final twist of the netting yarn.

b) Type and capacity of testing machine used, the

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[*] 1 kgf = 9.806 65 N (newton)≅10 N.

[†] 1 gf = 0.009 806 65 (newton)≅0.01 N.

type of holding devices employed and the range of indication.

c) The sampling method employed.

d) Number of specimens tested.

e) Number of irregular tests (*see* **6.1**).

f) The kind and time of wetting (with or without wetting agents).

g) The average breaking load in kilogram force.

h) Any deviation from the test procedure.

j) If required, the coefficient of variation of the breaking load confidence interval.

k) The average tenacity in gram force per tex.

m) The average breaking length in kilometres.

TESTS FOR FISHING GEAR MATERIALS DETERMINATION OF MESH BREAKING LOAD

[*Source* : IS 5815 (Part 5) : 1971]

1 SCOPE

1.1 This standard prescribes the method of testing of mesh breaking load of netting (webbing) in both the dry and wet state. Tests in the wet state are considered to be particularly appropriate in indicating the behaviour of the webbing in use.

2 TERMINOLOGY

2.0 For the purpose of this standard, the following definitions shall apply.

2.1 Mesh Breaking Load ($P_{Max}\,m$)

The breaking load, equal to the maximum load applied to a mesh observed during a breaking test. It may be either dry ($P_{Max}\,md$) or wet ($P_{Max}\,mw$).

2.2 Time-to-Break

The time, in seconds, taken to reach the mesh breaking load measured from the moment of application of the load.

3 PRINCIPLE

3.1 A mesh is extended in dry or wet state until one of the knots or joints reaches the load at rupture by suitable apparatus that records or indicates the applied load.

3.2 The testing machine shall be operated at such a rate that the average time-to-break of a group of specimens falls within specified time limits.

4 CONDITIONING OF TEST SPECIMENS

4.1 Testing in the Dry State

The specimens to be tested in the dry state shall be conditioned to a state of moisture equilibrium from dry side in standard atmosphere at 65 ± 2 percent relative humidity and 27 ± 2°C temperature.

4.1.1 When a test sample under above conditions has been left in such a way as to expose, as far as possible, all portions of it to the standard atmosphere for 24 hours, the test sample shall be deemed to have reached the state of moisture equilibrium.

4.2 Testing in the Wet State

All specimens to be tested in the wet state shall be immersed in tap water without wetting agents at room temperature for a period of not less than 12 hours. Surplus water shall then be shaken off.

4.2.1 A shorter time of immersion (one hour) may be used with the addition of wetting agents.

5 ATMOSPHERIC CONDITIONS FOR TESTING

5.1 The tests shall be carried out in the standard atmosphere (or where it is not possible to carry out the tests in the standard atmosphere, they shall be carried out immediately after the removal of the sample from the standard atmosphere).

6 NUMBER OF TESTS

6.1 At least 20 single tests on each piece of netting shall be carried out. If a distinct confidence interval for the main values is prescribed, as many additional tests shall be carried out as necessary to secure that interval.

7 APPARATUS

7.1 Tensile Testing Machines

Testing machines shall be of any one of the following types:

a) constant rate of elongation,
b) constant rate of load, or
c) constant rate of traverse.

7.1.1 The clamps of the tensile testing machine shall be replaced by pins of stainless steel material which stand at right angles to the direction of pull. This shall be of sufficient strength and have a diameter suitable for the mesh size. Alternatively, loops of netting yarn heavier than that of the netting may be used. It is necessary to use these loops if the meshes are very small.

7.1.2 The maximum error of the indicated load at any point in the range in which the machine is used shall not exceed ± 1 percent. The accuracy of the graduated scale of the apparatus shall be checked dynamically as for example, by means of calibrated springs of appropriate characteristics.

7.1.3 The testing machine shall be capable of testing mesh specimens having different mesh openings.

7.1.4 The testing machine shall include facilities for producing different rates of loading in order to break specimens in the specified average time-to-break.

7.2 Suitable Equipment

In which specimens can be immersed in water preparatory to wet testing.

8 PREPARATION OF TEST SPECIMENS

8.1 To prevent untwisting of the loose ends, the procedure in 8.1.1 and 8.1.2 shall be followed.

8.1.1 *Netting with Small Meshes*

A sample of netting may be cut with a size of 3 × 3 meshes. The mesh strength has to be determined on the central mesh.

8.1.2 *Netting with Large Meshes*

The loose ends of the sample mesh are cut as far as possible from the knots or joints. Wherever feasible, melting shall be preferred to cutting.

9 TEST PROCEDURE

9.1 Check that the pins or loops of the testing machine are properly aligned and parallel so that with the application of force to the specimen no angular deflection is caused.

9.1.1 Mount the specimen in the testing machine over the pins or loops (*see* Fig. 1).

9.1.2 Apply the force to reach the prescribed mean time-to-break. Discard all observations obtained on test specimens of which the loose ends of the mesh are slipping in the knots or the joints dissolve. In such an event the test shall be repeated with a new specimen. The number of observations discarded as above shall be noted. If a test specimen does not break at one of the knots or joints, the test shall be discarded In the case of testing in wet state, the sample shall be tested immediately after removal from water.

9.1.3 If more than 10 knots or 20 meshes tested are slipping, the method of mesh testing described in this standard shall not be used. It shall be replaced by testing the knot of the netting by fastening all four ends in the holding devices of the testing machine (*see* Section F/4).

If the meshes are too small to ensure that all four ends of the knot are gripped by the holding devices, the knots around the knot to be tested shall be opened (*see* Fig. 2).

10 CALCULATION AND EXPRESSION OF RESULTS

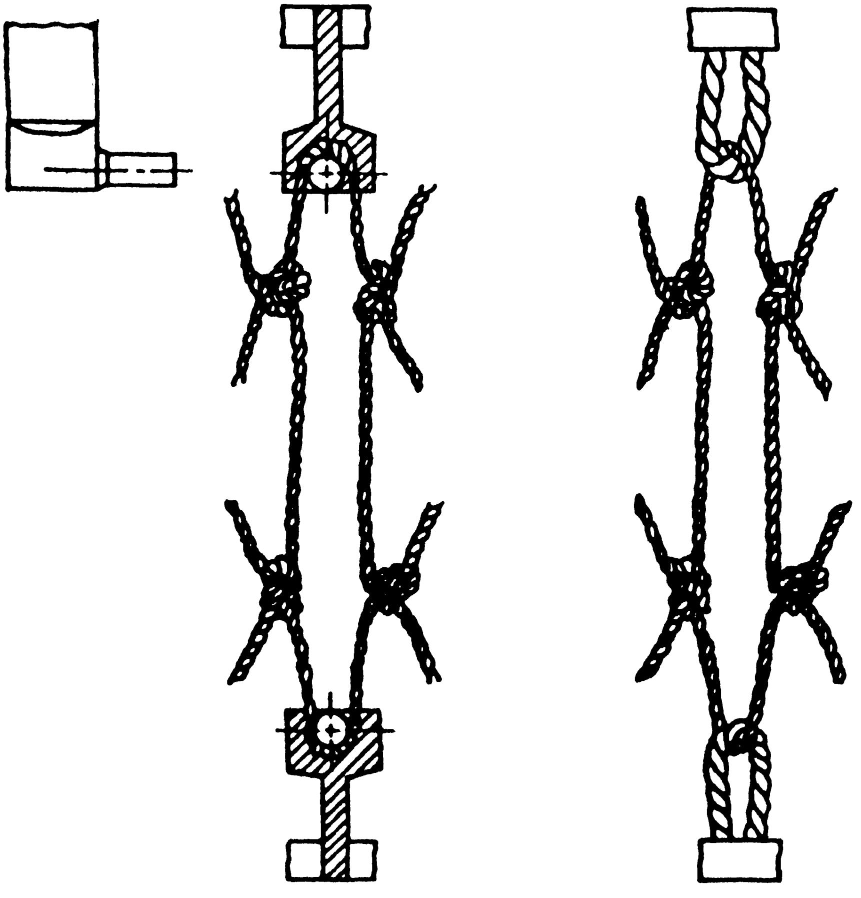
10.1 Average mesh breaking load ($P_{Max\,m}$) in kgf $= \dfrac{\Sigma P_{Max\,m}}{n}$

where

$\Sigma P_{Max\,m}$ = the sum of the observed values for mesh breaking loads, expressed in kgf; and

n = the number of observations.

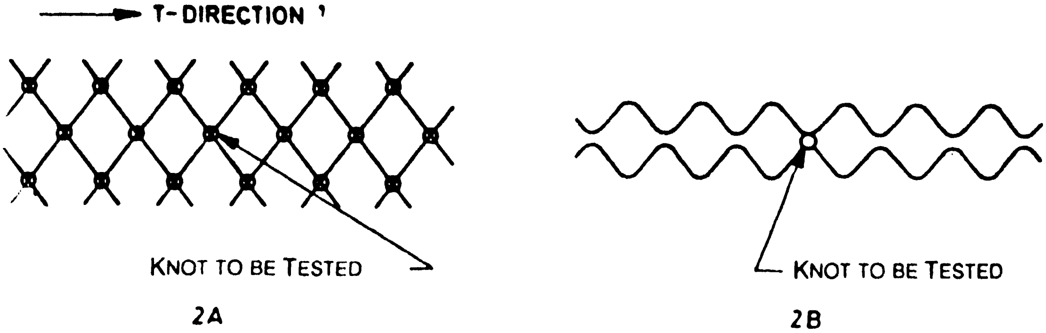
Calculate the average breaking load to four significant figures and round it off to three significant figures.



1A Pin Mounting

1B Loop Mounting

Fig. 1 Mounting of the Specimen



2A 2B

FIG. 2 TESTING OF THE KNOT

10.2 If necessary, the coefficient of variation and the confidence interval may be calculated by recognized statistical methods.

NOTE — 1 kgf = 9.86 65 N (newton).

11 REPORT

11.1 The report shall state that the tests were performed in accordance with this Indian Standard. The date of the test and the following shall be stated:

a) Description of the netting (type of material, type of fibre, type of knot, mesh size and preparation).

b) Type and capacity of testing machine used, the type of holding devices employed and the range of indication.

c) The sampling method employed.

d) Number of specimens tested.

e) Number of irregular tests.

f) The kind and time of wetting (with or without wetting agents).

g) The average breaking load in kgf.

h) Any deviation of the test procedure.

j) If required, the coefficient of variation of the breaking load and confidence interval.

TESTS FOR FISHING GEAR MATERIALS DETERMINATION OF CHANGE IN LENGTH OF NETTING YARNS AFTER IMMERSION IN WATER

[*Source* : **IS 5815 (Part 6) : 1981**]

This standard is mainly based on ISO 3090-1974 Netting yarns – Determination of change in length after immersion in water.

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1 SCOPE

1.1 This standard prescribes the method for determining the change in length of netting yarns after immersion in water.

2 PRINCIPLE

2.1 A length of netting yarn on which two marks have been made at a prescribed distance apart is immersed in water at a given temperature. Measurement of the change in length between the two marks is made.

3 APPARATUS

3.1 The apparatus shall allow the measurement of a length of yarn of 1 000 ± 1 mm with an accuracy of 1 mm and the application of a tension by means of a weight suspended from one end of the yarn. The important components of the apparatus shall be:

a) a hook or a clamp at one end to fasten the netting yarn to be tested·

b) a free-turning pulley on the other end, on which the specimen is placed and tensioned;

c) a measuring-scale graduated in centimetres and millimetres;

d) Two double-indicator devices movable on a metal rod. The horizontal pointers give the measured value on the scale when the vertical pointers above them are in contact with the marks on the specimen.

NOTE – An outline of a suitable apparatus based on the above principle is given in Fig.1.

4 SAMPLING

4.1 Sampling shall be carried out in accordance with the procedure laid down in the relevant standards or as agreed to between the interested parties.

5 PREPARATION OF TEST SPECIMENS

5.1 The specimens shall be removed from the package or the netting, before exposure in the standard atmosphere, in such a manner that there is no alteration in the construction.

5.2 The netting yarn shall be cut in pieces of appropriate length for the measuring apparatus (*see* 3). The ends of each length shall be melted or knotted.

5.3 The single pieces of netting yarn to be measured shall be taken at random from the package or the netting.

6 REQUIREMENTS FOR TESTING

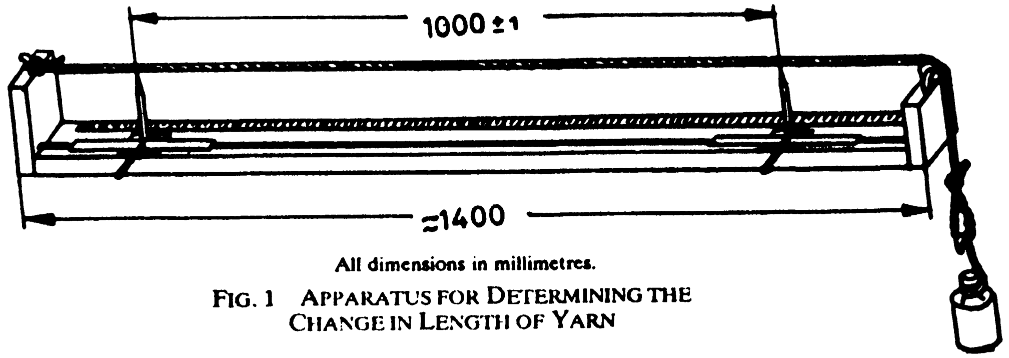
6.1 Atmosphere for Testing

Before immersion in water, the specimens shall be exposed for a period of 24 hours to the standard atmosphere for testing.

6.2 Testing in the Wet State

6.2.1 All specimens to be tested in the wet state shall be immersed in tap water, without wetting agents, at a temperature of 27 ± 2°C for a period of not less than 12 hours.

6.2.2 By agreement between the interested parties, a shorter wetting time with the addition of a wetting



All dimensions in millimetres.

FIG. 1 APPARATUS FOR DETERMINING THE CHANGE IN LENGTH OF YARN

agent may be used.

6.3 Distance Between Marks

The distance between the marks on the specimen shall be 1 000 ± 1 mm.

6.4 Tension

The tension used for all measurements shall correspond to the weight of 250 ± 25 m of the netting yarn to be tested. The tension shall be constant for all specimens taken from any one sample and shall be applied in such a manner that sudden tautening of the yarn is avoided.

7 NUMBER OF TESTS

7.1 At least five specimens of each sample shall be tested. If a distinct confidence interval for the mean value is prescribed, as many additional tests are to be carried out as are necessary to secure this confidence interval.

8 PROCEDURE

8.1 Take precautions to ensure that the construction of the specimen is not altered during handling and measurement of the specimens.

8.2 Fasten one end of the conditioned specimen of the netting yarn of sufficient length to the hook or grip of the apparatus and hang the weight at the other end (*see* Fig. 1).

8.3 Indicate the length to be measured on the specimens by two marks, 1 000 ± 1 mm apart. Measure the distance between the marks on each specimen to accuracy of ± 1 mm and record the result (A).

8.4 Immerse each specimen in water (*see* 6.2) and remeasure the distance between the marks immediately after removal from the water to an accuracy of ± 1 mm and record the result (B).

8.5 Dry the specimens for 24 hours freely suspended in the standard atmosphere for testing. Measure again the distance between the marks on each specimen to an accuracy of ± 1 mm and record the result (C).

9 CALCULATION AND EXPRESSION OF RESULTS

9.1 Calculate the arithmetic mean of the recorded measurements at each stage (A, B and C) and designate the means as A_1, B_1 and C_1. Using these arithmetic means, calculate the changes in length caused by wetting ($B_1 - A_1$) and by drying again ($C_1 - A_1$). In each case, express the changes in length as percentages of the initial mean conditioned length (A_1).

10 TEST REPORT

10.1 The test report shall include the following information:

a) the type and designation of the netting yarn;

b) the number of specimens tested;

c) the average changes in length caused by wetting ($B_1 - A_1$) and drying again ($C_1 - A_1$), measured both in the wet state and in the dried state, expressed as percentages of the initial distance between the marks (A_1);

d) if required, the coefficient of variation of the dimensional changes and the confidence interval.

TESTS FOR FISHING GEAR MATERIALS DETERMINATION OF ELONGATION OF NETTING YARNS

[*Source* : 5815 (Part 7) : 1986]

This standard is mainly based on ISO 3790-1976 'Fishing nets – Determination of elongation of netting yarns', issued by the International Organization for Standardization. Compatible alterations have been made to suit conditions prevailing in the industry.

1 SCOPE

1.1 This standard prescribes the method for determination of elongation of netting yarns. Tests in the west state on the yarns are considered to be particularly appropriate in indicating the behaviour of the yarns in the use.

2 DEFINITIONS

2.0 For the purpose of this standard, the following definitions shall apply.

2.1 Knot-Breaking Load

The breaking load, equal to the maximum load observed during a breaking test on netting yarn with a weaver's knot.

NOTE – Distinction is made between the dry knot-breaking load and the wet knot-breaking load.

2.2 Elongation

The increase in length of a specimen during a tensile test, expressed as a percentage of the nominal gauge length.

2.3 Elongation at Half the Knot-Breaking Load

The elongation after applying a pre-tension, produced on a specimen at half the knot-breaking load.

2.4 Load/Elongation Curve

A graphical representation showing the relationship between the change in length of the pre-tensioned specimen and the magnitude of the applied stress.

2.5 Duration of Testing

The time in seconds taken to reach half the knot-breaking load, measured from the moment of application of the force, after application of pre-tension.

2.6 Pre-tension

The tension applied to straighten the specimen.

2.7 Nominal Gauge Length

The length of specimen between the faces of the upper and lower grips of the testing machine, after application of pre-tension.

3 PRINCIPLE

3.1 A prescribed length of netting yarn in the dry or wet state without knot is extended under increasing tensile load until that load reaches half the values of the corresponding dry or wet knot-breaking load. The test is performed using a suitable apparatus that records the amount of elongation.

4 CONDITIONING OF TEST SPECIMENS

4.1 Testing in the Dry State

The test sample to be tested in the dry state shall be conditioned to a state of moisture equilibrium from dry side in standard atmosphere at 65 ± 2 percent relative humidity and 27 ± 2°C temperature.

4.1.1 When a test sample under the above conditions has been left in such a way as to expose, as far as possible, all its portions to the standard atmosphere for 24 hours, the test sample shall be deemed to have reached the state of moisture equilibrium.

NOTE – For netting yarns of man-made fibres, a period of 24 hours exposure is generally sufficient.

4.2 Testing in the Wet State

All test specimens to be tested in the wet state shall be immersed in tap water without wetting agents at temperature of 27 ± 2°C for a period of not less than 12 hours. Surplus water shall then be shaken off.

5 ATMOSPHERIC CONDITIONS FOR TESTING

5.1 The test shall be carried out in the standard atmosphere, or where it is not possible to carry out the test in standard atmosphere, they shall be carried out immediately after removal of the sample from the standard atmosphere.

6 NUMBER OF TESTS

6.1 At least 20 single valid tests for each sample package shall be carried out. If a distinct confidence interval for the main value is prescribed, as many additional tests shall be carried out as necessary to secure that interval.

7 APPARATUS

7.1 Tensile Testing Machine

Either of the following types may be used:

a) *Constant Rate of Elongation Machine* – After the first 2 seconds of the test, the rate of increase in the distance between the clamps shall not differ by more than 5 percent from the average of increase over the whole period of the tests.

b) *Constant Rate of Traverse Machine for Example Pendulum Type* – After the first 2 seconds of the test, the average rate of traverse of the pulling jaw in any 2 seconds interval shall not differ by more than 5 percent from the average rate of traverse over the whole period of the test.

Preference should be given to a constant rate of elongation machine, which shall always be used for arbitration purposes.

7.1.1 The testing machine shall include a pair of flat grips to hold the specimen without slipping or damage, to ensure an accurate specimen length and to allow the application of a pre-tension (*see* Fig. 1).

7.1.2 The testing machine shall be capable of operating with a starting distance between grips of 250 mm.

7.1.3 The testing machine shall include facilities for producing different speeds of traverse in order to test specimens in the specified time for testing.

7.1.4 The testing machine shall be equipped with an autographic recorder for the load-elongation curve. The dynamic response of any recorder must be

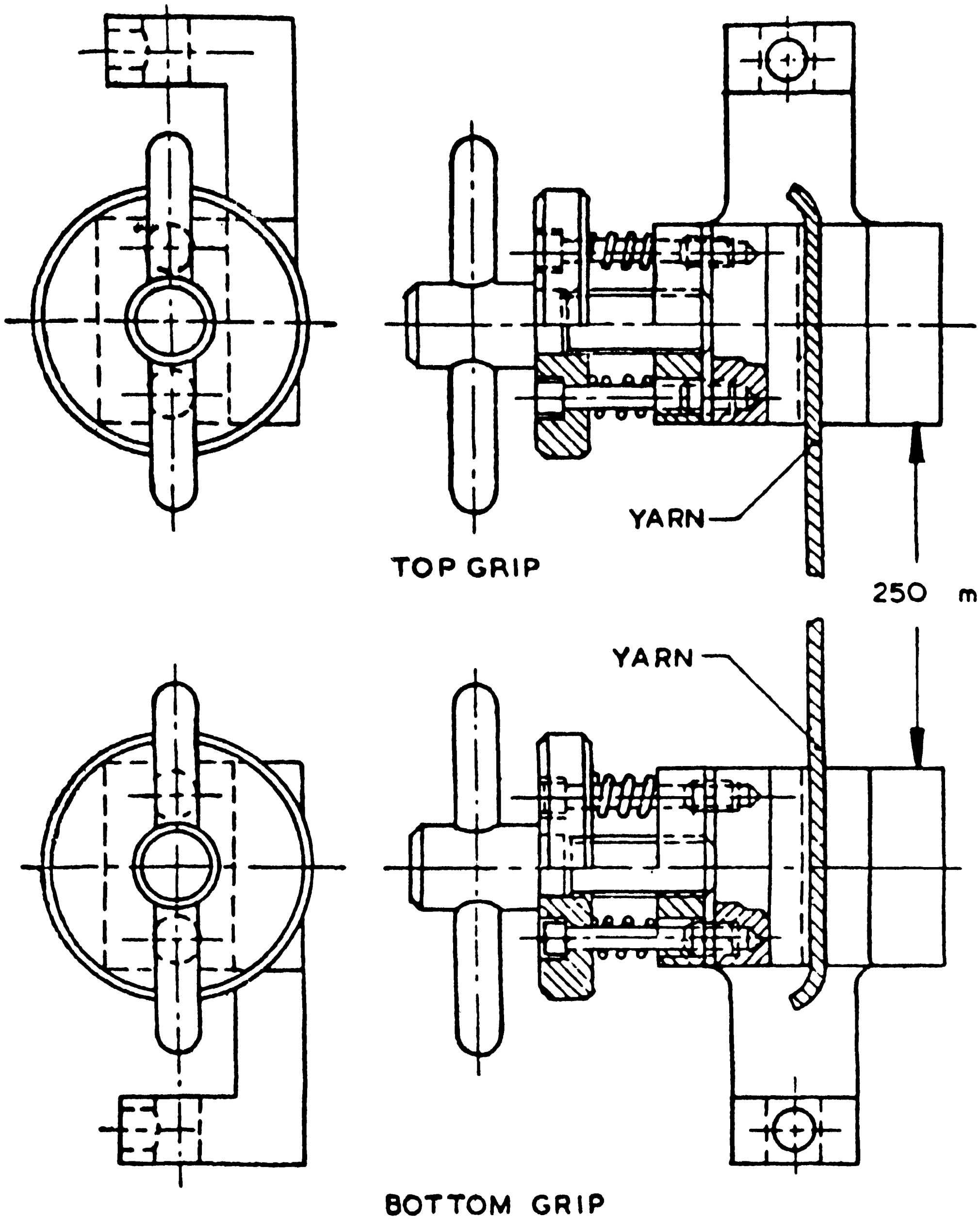


FIG. 1 HOLDING GRIPS FOR THE TESTING OF NETTING YARNS WITHOUT KNOTS

sufficiently rapid that it will accurately record the steepest part of the load-elongation curve.

7.2 Equipment for producing and maintaining the standard atmosphere for testing (*see* 5.1).

7.3 Equipment in which specimens can be immersed in water preparatory to wet testing.

8 PREPARATION OF SPECIMENS

8.1 The specimen shall be removed from its package or taken from the netting in such a manner that there is no alteration in the construction.

8.2 If the elongation of yarn taken from netting is to be tested, knots shall be undone to obtain pieces of netting yarn of at least 400 mm length. Precautions shall be taken to avoid damage, stretching and change of construction of the specimen.

9 PROCEDURE

9.1 Before testing for elongation, determine the relevant mean knot – breaking load wet or dry of the netting yarn. (*see* Section F/4).

9.2 Test wet specimens immediately after removal from the water.

9.3 Mount the specimens in the testing machine in such a manner as to prevent slippage and avoid damage to the specimen in the grips with the axis of the specimen parallel to and coincidental with the direction of the applied tensile force.

9.4 Apply a pre-tension (*see* Note) to remove kinks and just straighten the specimen.

NOTE – The pre-tension shall correspond to the mass of 250 ± 25 m of the netting yarn to be tested. If this pre-tension is not sufficient to remove kinks and to just straighten the specimen, a higher pre-tension shall be applied. The value shall be recorded specially in the test report, because of the influence on the elongation results.

9.5 Check that the length of the specimen under pre-tension, is accurately 250 mm between the grips at the commencement of the test.

9.6 Increase the tensile force continuously until, within the prescribed time, it corresponds to half the knot-breaking load. (*see* Section F/4).

9.7 Discard all observations obtained on specimens which slip between the grips or break completely or partially before reaching half the relevant knot-breaking load. Record the number of observations so discarded.

10 CALCULATION AND EXPRESSION OF RESULTS

10.1 Calculate the mean values of the elongations and express them in percentages of the nominal gauge length under pre-tension.

10.2 If necessary, the coefficient of variation and the confidence interval may be calculated by recognized statistical methods.

11 REPORT

11.1 The report shall include the following particulars:

a) A statement that the tests were performed in accordance with this Indian Standard;

b) The date of the test;

c) A description of the material tested (type, linear density and construction of the netting yarn);

d) The type and capacity of testing used and the range of the indication;

e) The sampling method employed;

f) The number of specimens tested:

  1) wet

  2) dry

g) The number of invalid tests;

h) The method and time of wetting (with or without wetting agents);

j) The load/elongation at half the knot-breaking load;

k) The mean elongation at half the knot-breaking load;

m) The actual mean duration and the range of durations of the test;

n) Any deviation from the specified test procedure; and

p) The coefficient of variation of the elongation and the confidence interval (if required).

TESTS FOR FISHING GEAR MATERIALS DETERMINATION OF SINKING SPEED

[*Source* : IS 5815 (Part 8) : 1988]

The ability of twines and different types of nets to keep afloat or sink is associated with the type of material, specific gravity, thickness, twist, construction of the nets, etc. Whether the ability to float for a long time or the ability to sink quickly is important, depends on the type of fishing gear. The selection of nets is made and the treatment of twines and nets is carried out keeping in view the end use or working requirements of the nets.

1 SCOPE

1.1 This standard prescribes a method for determination of sinking speed of fishing twines and nets.

2 PRINCIPLE

2.1 A known length of specimen is allowed to sink in a vertical column of water through a fixed distance. From the time taken to sink a known distance, sinking speed is calculated in term of length per unit time (cm/s).

3 APPARATUS

3.1 Glass Jar or Beaker

At least 60 cm in length and 10 cm in diameter and preferably graduated in millimetres.

3.2 Stop Watch

4 SAMPLING

4.1 Sampling shall be carried out in accordance with the procedure laid down in the relevant specification or as agreed to between the interested parties.

5 ATMOSPHERIC CONDITIONS FOR CONDITIONING

5.1 The conditioning of the test specimens prior to testing shall be done in the standard atmosphere.

6 PREPARATION OF TEST SPECIMENS

6.1 The specimens shall be removed from the package or the netting before exposure in the standard atmosphere, in such a manner that there is no alteration in the construction.

6.2 The netting yarn specimens shall be cut into lengths of 2 cm and their ends shall be glued or melted. Put a knot in the centre of the specimens.

6.3 First condition the test specimen as in 5.1 for 12 hours and then immerse the specimen in water at 27 ± 2°C for 24 hours.

6.3.1 By agreement between the interested parties, a shorter wetting time with the addition of a wetting agent may be decided.

7 PROCEDURE

7.1 Take the glass jar or beaker and mark a distance of 50 cm as shown in Fig. 1. Fill it with salt solution of sp gr 1.020 up to mark *AB*.

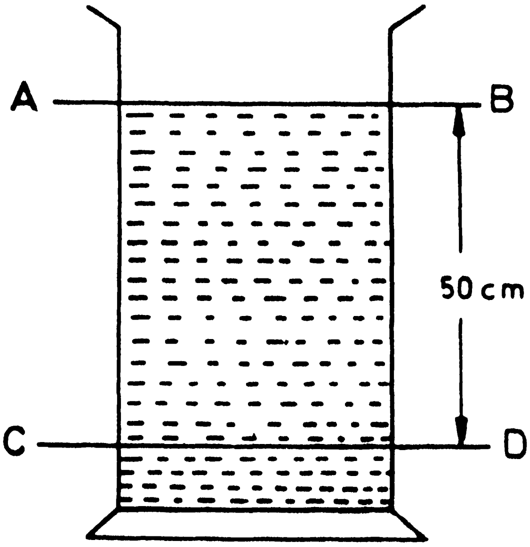


FIG. 1 GLASS JAR/BEAKER

7.2 Take out the specimen from the water (6.3) and remove the air bubbles if any from the surface of the specimen. Place it in the centre of the beaker on the surface of water and start the stop watch.

7.3 Note the time taken by the specimen to sink from mark *AB* to mark *CD* (*see* Note).

NOTE — Readings in which the test specimens sink in a diagonal-way or sink close to the well of the vessel should be discarded and fresh reading taken in lieu thereof.

7.4 Test at least five test specimens.

8 CALCULATIONS

8.1 Calculate the sinking speed by taking into consideration all the observations as under:

$$\text{Sinking speed, cm/s} = \frac{50 \times \text{No. of observations}}{\text{Total time taken in seconds}}$$

9 REPORT

9.1 The report shall include the following information:

a) Type of material tested;

b) Number of specimens tested;

c) Specific gravity of salt solution; and

d) Sinking speed, cm/s.

TESTS FOR FISHING GEAR MATERIALS DETERMINATION OF CUTTING RATE

(*Source* : IS 9945 : 1981)

This standard is mainly based on ISO 2075 - 1972 Method for cutting netting to shape – Determination of the cutting rate.

---

1 SCOPE

1.1 This standard prescribes a method for the determination of the cutting rate for both knotted and knotless netting, with or without regard to the general course of the netting yarn.

2 PRINCIPLE

2.1 In order to determine the cutting rate C for cutting netting to shape, the following must be known:

a) The total number of rows of meshes to be gained or lost;

b) The number of rows of meshes at the end of which the desired taper shall be reached.

NOTES

1 The letters N, T, K, B used in this standard designate one cut each in the direction indicated:

N = one cut in the N-direction;

T = one cut in the T-direction;

K = one cut in either N- or T-direction; and

B = one cut in AB direction (All Bars).

2 A clear distinction is made between 'rows of meshes' (lost or gained) only in the case of the manufacture of a tapered piece of netting by hand. Here, after the first row of meshes has been knotted, meshes are lost or gained in relation to the first row when knotting the adjacent rows.

In the case of tapering machine-made netting, which is the subject of this standard, the existing rows of meshes in both directions are severed by taper cuts. It is, however, admissible, for simplicity, to speak of meshes instead of rows of meshes.

For calculating the number of rows of meshes, the following rule is valid:

The rows of meshes to be counted are only those that are severed by cuts belonging to the cutting rate. Rows of meshes severed by initial or final cuts not belonging to the cutting rate, for example, an N-cut for the cutting rate 1T3B or an N- or T- cut in the case of an AB- cut, do not count.

3 Whereas all K-cuts of a taper cut are executed in the direction of the larger of the two values a and b (symbol M, *see* below), all initial or final K-cuts that do not belong to the cutting rate will always be in the direction of the value m (the smaller of the two values a and b, *see* below).

For the calculations as described below, letter symbols for the number of rows of meshes (or of meshes, *see* Note 2) are used as follows:

M is the larger of the numerical values for a and b;

m is the smaller of the numerical values for a and b;

M' and m' are the numerical values obtained by simplification of the fraction arising from M and m (*see* 3).

If the general course of the netting yarn has to be regarded for the calculation of the cutting rate, it must be known whether M is parallel to the N-direction (then N- and B-cut are needed) or M is parallel to the T-direction (then T-and B- cuts are needed).

3 TAPER RATIO, DEFINITION AND CALCULATION

3.0 The taper ratio R is the ratio between the number of meshes counted in the T-direction and the number of meshes counted in the N-direction of the desired taper. It is written as a fraction:

$$R = \frac{a}{b} = \frac{\text{Number of meshes counted in T-direction } (m \text{ or } M)}{\text{Number of meshes counted in N-direction } (M \text{ or } m)}$$

becoming after simplification

$$\text{either} \quad R = \frac{m'}{M'}, \ (\textit{see } 3.1)$$

$$\text{or} \quad R = \frac{M'}{m'}, \ (\textit{see } 3.2)$$

When regarding the general course of the netting yarn, the following is valid.

3.1 M Parallel to the N-Direction:

$$R = \frac{m}{M} \text{ or, after simplification, } R = \frac{m'}{M'}$$

Example:

M = 15, parallel to the N-direction

m = 6

$$R = \frac{m}{M} = \frac{6}{15} \text{ or, after simplification,}$$

$$R = \frac{m'}{M'} = \frac{2}{5}$$

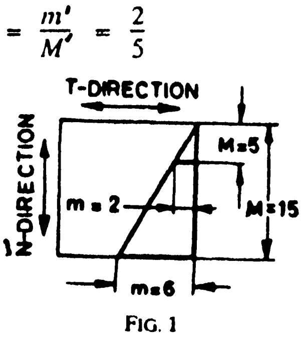


FIG. 1

3.2 *M* Parallel to the T-Direction:

$$R = \frac{M}{m} \text{ or, after simplification, } R = \frac{M'}{m'}$$

Example:

$M = 15$, Parallel to the T-direction

$m = 6$

$$R = \frac{M}{m} = \frac{15}{6} \text{ or, after simplification,}$$

$$R = \frac{m'}{M'} = \frac{5}{2}$$

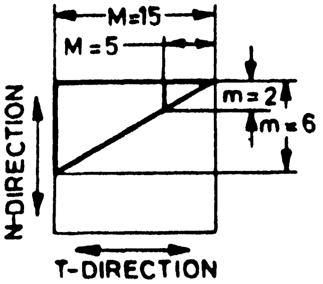


FIG. 2

The values for M' and m indicate the number of meshes served by one element of the taper cut, the numerator of the fraction representing the number of meshes in the T-direction, the denominator the number of meshes in N-direction.

Example:

$R = \frac{2}{5}$ means that by any element of the desired taper cut 2 meshes are severed in the T-direction and 5 meshes in the N-direction.

4 DETERMINATION OF THE CUTTING RATE

4.1 By Reading from a Table

After calculation of the taper ratio, the cutting rate can be read immediately from Table 1.

4.1.1 In Table 1, the numerators 1 to 10 of the fraction representing the taper ratio are given above the columns and the denominators 1 to 20 are indicated on the left. The desired cutting rate C is found at the intersection of the numerator column and the denominator row.

Examples:

$R - \frac{2}{5}$ $C = 3N4B$

$R = \frac{2}{1}$ $C = 1T2B$

$R = \frac{1}{1}$ $C = AB$

4.2 By Calculation

The cutting rate can be calculated either:

a) by means of the values M' and m' (that result from a simplification of M and m before the calculation); or

b) by means of the values M and m and a simplification at the end of the calculation.

4.2.1 Using the values M' and m', the following values are obtained:

- the number of K (N - or T -) cuts in the cutting rate $M' - m'$.

These cuts are N-cuts, if M' is parallel to the N-direction, and T-cuts, if M' is parallel to the T-direction.

- the number of B-cuts in the cutting rate: $2m'$

The cutting rate is designed by the formula

$$C = (M' - m')\, K 2m\, B$$

Examples:

Taper ratio $R = \frac{m'}{M'} = \frac{2}{5}$ M'

parallel to the N-direction (*see* **4.1**):

Number of N-cuts : $M' - m' = 5 - 2 = 3$

Number of B-cuts : $2m' = 2 \times 2 = 4$

Cutting rate $C = 3N4B$

2 Taper ratio $R = \frac{M'}{m'} = \frac{5}{2}$

M' parallel to the T-direction (*see* **4.1**):

Number of T-cuts : $m' - M' = 5 - 2 = 3$

Number of B-cuts : $2m' = 2 \times 2 = 4$

Cutting rate $C = 3T4B$

4.2.2 Using the values M and m, the following values are obtained:

— the total number of K — (N- or T-) cuts in the taper cut: $M - m$

These cuts are N-cuts, if M is parallel to the N-direction, and T-cuts, if M is parallel to the T-direction.

— the total number of B-cuts in the taper cut: $2m$

The cutting rate is found by simplification of the fraction.

$$\frac{\text{Total number of K-cuts}}{\text{Total number of B-cuts}} = \frac{M - m}{2m}$$

After simplification, the numerator of the fraction

Table 1 Cutting Rates

(*Clause* 4.1)

Denominator of the Taper Ratio *R*	Numerator of the Taper Ratio *R*									
	1	2	3	4	5	6	7	8	9	10
	Cutting rate C									
1	AB	1T2B	2T2B 1T1B	3T2B	4T2B 2T1B	5T2B	6T2B 3T1B	7T2B	8T2B 4T1B	9T2B
2	1N2B	AB	1T4B	2T4B 1T2B	3T4B	4T4B 1T1B	5T4B	6T4B 3T2B	7T4B	8T4B 2T1B
3	2N2B 1N2B	1N4B	AB	1T6B	2T6B 1T3B	3T6B 1T2B	4T6B 2T3B	5T8B	6T6B 1T1B	7T6B
4	3N2B	2N4B 1N2B	1N6B	AB	1T8B	2T8B 1T4B	3T8B	4T8B 1T2B	5T8B	6T8B 3T4B
5	4N2B 2N1B	3N4B	2N6B 1N3B	1N8B	AB	1T10B	2T10B 1T5B	3T10B	4T10B 2T5B	5T10B 1T3B
6	5N2B	4N4B 1N1B	3N6B 1N2B	2N8B 1N4B	1N10B	AB	1T12B	2T12B 1T6B	3T12B 1T4B	4T12B 1T8B
7	6N2B 3N1B	5N4B	4N6B 2N3B	3N8B	2N10B 1N5B	1N12B	AB	1T14B	2T14B 1T7B	3T14B
8	7N2B	6N4B 3N2B	5N6B	4N8B 1N1B	3N10B	2N12B 1N6B	1N14B	AB	1T16B	2T16B 1T8B
9	8N2B 4N1B	7N4B	8N6B 1N1B	5N8B	4N10B 2N5B	3N12B 1N4B	2N14B 1N7B	1N16B	AB	1T18B
10	9N2B	8N4B 2N1B	7N6B	6N8B 3N4B	5N10B 1N2B	4N12B 1N3B	3N14B	2N16B 1N8B	1N18B	AB
11	10N2B 5N1B	9N4B	8N6B 4N3B	7N8B	6N10B 3N5B	5N12B	4N14B 2N7B	3N16B	2N18B 1N9B	1N20B
12	11N2B	10N4B 5N2B	9N6B 3N2B	8N8B 1N1B	7N10B	6N12B 1N2B	5N14B	4N16B 1N4B	3N18B 1N6B	2N20B 1N10B
13	12N2B 6N1B	11N4B	10N6B 5N3B	9N8B	8N10B 4N5B	1N12B	6N14B 3N7B	5N16B	4N18B 2N9B	3N20B
14	13N2B	12N4B 3N1B	11N6B	10N8B 5N4B	9N10B	8N12B 2N3B	7N14B 1N2B	6N16B 3N8B	5N18B	4N20B 1N5B
15	14N2B 7N1B	13N4B	12N6B 2N1B	11N8B	10N10B 1N1B	9N12 3N4B	8N14B 4N7B	7N16B	6N18B 1N3B	5N20B 1N4B
16	15N2B	14N4B 7N2B	13N6B	12N8B 3N2B	11N10B	10N12B 5N6B	9N14B	8N16B 1N2B	7N18B	6N20B 3N10B
17	16N2B 8N1B	15N4B	14N6B 7N3B	13N8B	12N10B 6N5B	11N12B	10N14B 5N7B	9N16B	8N18B 4N9B	7N20B
18	17N2B	16N4B 4N1B	15N6B 5N2B	14N8B 7N4B	13N10B	12N12B 1N1B	11N14B	10N16B 5N8B	9N18B 1N2B	8N20B 2N5B
19	18N2B 9N1B	17N4B	16N6B 8N3B	15N8B	14N10B 7N5B	13N12B	12N14B 6N7B	11N16B	10N18B 5N9B	9N20B
20	19N2B	18N4B 9N2B	17N6B	16N8B 2N1B	15N10B 3N2B	14N12B 7N6B	13N14B	12N16B 3N4B	11N18B	10N20B 1N2B

indicates the number of K-cuts, the denominator the number of B-cuts in the cutting rate. These values correspond to the results of the calculations using $M' - m'$ and $2m'$

Examples:

1 $M = 15$, parallel to the N-direction, $m = 6$

$$\frac{\text{Total number of N-cuts}}{\text{Total number of B-cuts}} = \frac{M - m}{2m} = \frac{15 - 6}{2 \times 6} = \frac{9}{12}$$

and after simplification $= \frac{3}{4}$

Cutting rate $C = 3N4B$

2 $M = 15$, parallel to the T-direction, $m = 6$

$$\frac{\text{Total number of N-cuts}}{\text{Total number of B-cuts}} = \frac{M - m}{2m} = \frac{15 - 6}{2 \times 6} = \frac{9}{12}$$

and after simplification $= \frac{3}{4}$

Cutting rate $C = 3T4B$

NOTE — The formulae for the number of K-cuts ($M - m$) and for the number of B-cuts ($2m$) can be explained as follows:

By any B-cut a half mesh both in the N- and T- directions is severed. $2m$ B-cuts, therefore, will sever m meshes both in the N- and T-direction. Thereby, all meshes to be lost in the direction of m are severed and furthermore m of the M meshes to be cut in the other direction. In this direction, therefore, $M - m$ meshes remain to be out (*see also* Fig. 3). The number of K- (N- or T-) cuts and the number of B-cuts in any element of the cutting rate is found by simplification of the fraction $\frac{M - m}{2m}$ Correspondingly this explanation is valid for the formulae $M' - m'$ and $2m'$.

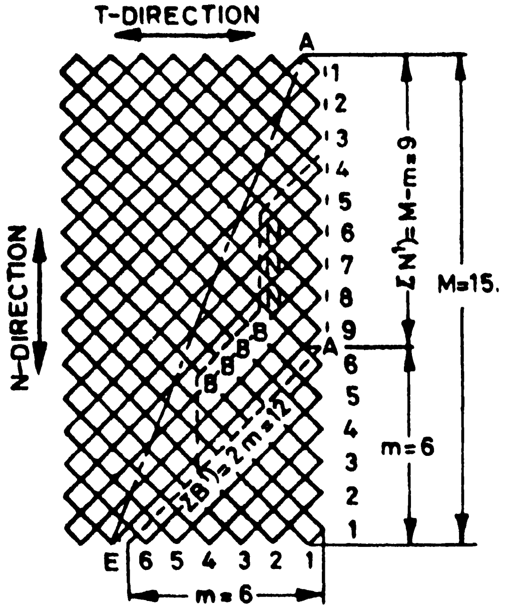


FIG. 3

Example:

$M = 15$, parallel to the N-direction, $m = 6$

$$\frac{\text{Total number of N-cuts}}{\text{Total number of B-cuts}} = \frac{M - m}{2m} = \frac{15 - 6}{2 \times 6} = \frac{9}{12}$$

and after simplification $= \frac{3}{4}$

Cutting rate $C = 3N4B$.

5 DETERMINATION OF THE CUTTING RATE FOR FLYING MESHES

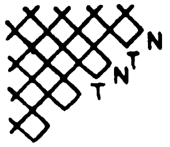
5.1 For special purposes, 'flying meshes' at the edges of the cut are sometimes needed.

5.2 The cutting rate for flying meshes can be read immediately from the fraction that indicates the taper ratio. The number of T-cuts is found in the numerator, the number of N-cuts in the denominator of the named fraction (*see* 3).

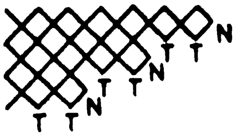
Example:

$R = \frac{1}{1}$, cutting rate for flying meshes $1N1T$

$R = \frac{2}{1}$, cutting rate for flying meshes $1N2T$



FLYING MESHES
OBTAINED BY
1N1T CUT



FLYING MESHES
OBTAINED BY
1N2T CUT

FIG. 4

6 SPECIAL CONDITIONS FOR KNOTLESS NETTING

6.1 In knotless netting, a general course of the netting yarn cannot always be determined. In many cases, however, it is possible to determine the largest possible length of the stretched mesh in the netting. For this reason, the designation of directions in knotless netting is defined as follows:

N-direction : The direction of the longest possible mesh axis.

T-direction : The direction at right angles to the

N-direction. The definition of the AB-directions is the same for both knotted and knotless netting.

For all knotless netting, where the N- and T-directions can be determined as explained above, the corresponding rules for knotted netting are valid accordingly.

If a determination of the direction is impossible, it is also impossible to discriminate between N- and T-cuts. In such cases only the number of K-cuts can be determined by means of the general formulae:

Total number of K-cuts = $M-m$

Number of K-cuts in the cutting rate = $M'-m'$

ANNEX A

DETERMINATION OF APPROXIMATE AND OF COMPLEX CUTTING RATES

A-0 In cases where the values $\frac{m}{M}$ and $\frac{M}{m}$ respectively or $\frac{M-m}{2m}$ cannot be simplified without remainder, the following possibilities are given in A-1 and A-2 for the determination of the cutting rate.

A-1 CHOICE OF AN APPROXIMATE VALUE

Example:

M = 143, parallel to the N - direction,
m = 100

$R = \frac{100}{143}$; this fraction cannot be simplified completely.

Instead, an approximate value of R is chosen:

$$R = \frac{100}{140} = \frac{10}{14} = \frac{5}{7}$$

$$\frac{\text{Number of N-cut} : M'-m'}{\text{Number of B-cuts} : 2m'} = \frac{7-5}{2 \times 5} = \frac{2}{10} = \frac{1}{5}$$

Approximate cutting rate C = $1N5B$.

A-2 DETERMINATION OF COMPLEX CUTTING RATES

Instead of an approximate cutting rate as described in A-1, complex cutting rates comprising two or more groups of different cutting rates can be used.

To find complex cutting rates, the total number of the K- (N- or T-) cuts in the taper cut and the total number of the B-cuts have to be determined first as described in Section 5.

Example:

M = 143, parallel to the N-direction , m = 100

Total number of N-cuts: $M-m$ = 143−100 = 43

Total number of B-cuts: $2m$ = 2 × 100 = 200

Cutting rate C = 43 N200B

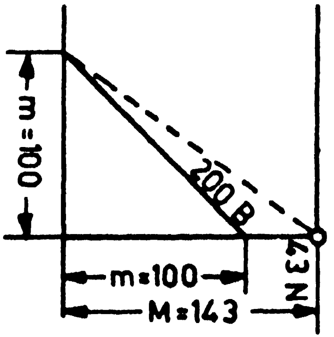


FIG. 5

The general procedure for determining complex cutting rates by co-ordinating in two or more groups a distinct number of K-(N-or T-) cuts with B-cuts or *vice versa* is illustrated by the following example.

The larger number of cuts (either $M-m$ or $2m$) is divided by the smaller one and the remainder is determined.

Example:

Total number of N-cuts: $M-m$ = 143 − 100 = 43

Total number of B-cuts: $2m$ = 2 × 100 = 200

200 (B-cuts): 43 (N-cuts) = 4, remainder 28 (B-cuts)

Thus, a cutting rate consisting of two groups is found:

First group: $1N4B$, to be repeated 43 times,

Second group: the remainder of 28B-cuts

This would give at once a better approximation to the ideal straight line cut.

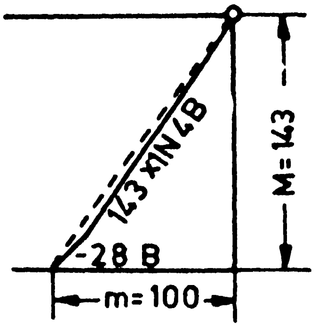


FIG. 6

To obtain the cut nearest to the straight line between the beginning and end of the cut, the remaining 28 B-cuts must be distributed as evenly as possible within the first group. To do so, this first group of 43 cuts 1*N*4*B* is split into two subgroups of;

a) 43 − 28 = 15 cuts 1*N*4*B* and

b) 28 cuts 1*N*4*B*, to which the remaining 28 B-cuts are added to form the new second group of 28 cuts 1*N*5*B*.

The netmaker will blend the cuts of the two groups 15 (1*N*4*B*) and 28 (1*N*5*B*), for example as follows:

14 (1*N*4*B* + 2 × 1*N*5*B*) + 1*N*4*B*, that is, to cut 14 times 1*N*4*B*, 1*N*5*B*, 1*N*5*B* and finally 1*N*4*B*.

For the given example, this would be the best solution.

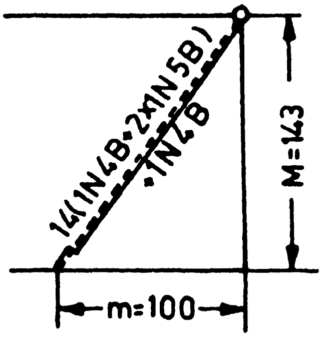


FIG. 7

SECTION G

TESTS FOR HOSIERY PRODUCTS

TESTS FOR GLOVES, WOOL, KNITTED DETERMINATION OF DIMENSIONS, MASS, WALES, COURSES, DIMENSIONAL CHANGE (DUE TO RELAXATION), DIMENSIONAL CHANGE (DUE TO FELTING) AND SCOURING LOSS

(*Source* : IS 5450 : 1986)

1 SCOPE

1.1 This standard prescribes the methods of tests for determining the dimensions, mass, wales, courses, dimensional change (due to relaxation), dimensional change (due to felting) and scouring loss of gloves, wool, knitted.

2 CONDITIONING OF TEST SPECIMENS AND ATMOSPHERIC CONDITIONS FOR TESTING

2.1 The test specimens shall preferably be conditioned for testing and tested in the standard atmosphere.

3 DIMENSIONS

3.1 Take a glove from the test sample. Lay it flat on a horizontal surface. Remove all creases and wrinkles without distorting it. Measure correct to the nearest millimetre the dimensions given in the specification.

4 MASS

4.1 Take a set of 10 pairs of gloves from the test sample. Condition them to moisture equilibrium for 24 hours (*see* **2.1**) and weigh to an accuracy of 10 g.

5 WALES

5.1 Take a glove constituting the test sample. Lay it flat on a horizontal surface. Remove all creases and wrinkles without distorting it. Count with the help of a pick glass or magnifying glass, the number of wales per decimetre at the required portion of the glove.

6 COURSES

6.1 Take a glove constituting the test sample. Lay it flat on a horizontal surface. Remove all creases and wrinkles without distorting it. Count with the help of a pick glass or magnifying glass, the number of courses per decimetre.

7 DIMENSIONAL CHANGE (DUE TO RELAXATION)

7.1 Marking of Test Specimens

Take a glove from the test sample. Mark centrally on it by means of indelible ink or a fast dyed cotton sewing thread an area 15 × 15 cm with two of its sides running in the direction of wales and the other two in the direction of courses. Spread this test specimen on a flat smooth surface, carefully removing by hand all creases and wrinkles. Within this area, mark six pairs of marks, three pairs each in the direction of wales and courses in such a way that the distance between each pair of marks is the same.

7.2 Procedure

7.2.1 Place test specimen on a glass plate and carefully remove by hand all creases and wrinkles without stretching the test specimen and place another glass plate on the test specimen. Measure correct to the nearest millimetre the distance between each pair of marks separately.

7.2.2 Lay the test specimen flat in a tray of suitable size and soak the specimen under a head of 25 mm of water containing 0.5 percent suitable wetting agent at room temperature for 2 hours. Drain out the water and remove the test specimen carefully so that it is not stretched. Lay the specimen flat on a smooth surface. Remove the excess water with the help of an absorbent material or by keeping the smooth surface in a sloping position. Dry the specimen at room temperature.

NOTE — Removal of excess water by wringing the test specimen is not permitted.

7.2.3 Proceed as in 7.2.1 and measure correct to the nearest millimetre the distance between each pair of marks separately. Preserve the specimen for **8.1.1** for determining felting shrinkage.

7.3 Calculation

7.3.1 Calculate separately the percentage of dimensional change for each pair of marks in the directions of wales and courses by the following formula:

Dimensional change (due to relaxation), percent

$$= \frac{a - b}{a} \times 100$$

where

a = the distance between a pair of marks (along the wales or courses as the case may be) before soaking, and

b = the distance between the same pair of marks after soaking.

7.3.2 Determine the average dimensional change (due to relaxation), percent in each direction.

8 DIMENSIONAL CHANGE (DUE TO FELTING)

8.1 Procedure

8.1.1 This test is to be carried out on the same specimen (*see* 7.2.3) for which the relaxation shrinkage has been determined. Soak it under a head of 25 mm of water containing 0.5 percent suitable wetting agent at 30 to 35°C for overnight. Drain out the water and remove excess water from the test specimen by passing through rubber wringers or using hydroextractor so that the water retained is about 60 percent of air-dry mass of specimen.

8.1.2 Evenly wet the specimen with 5 percent soap solution corresponding to 25 percent air-dry mass of the specimen. This is conveniently done by spraying it with soap solution by means of a pipette or burette. Subject the specimen to 2 000 blows at the rate of 70 blows per minute in a suitable single hammer milling machine (*see* Note), taking care that those portions of the specimen received initial hammering which are least exposed to severe milling during actual use. Wash the specimen in distilled water. Dry and condition it to moisture equilibrium at room temperature. Measure the distance between the different pairs of marks as in **7.2.1**.

NOTE — The air-dry mass of a charge for the milling machine should be about 170 g. Accordingly, sufficient quantity of entirely unfeltable woollen knitted goods may be added to form a charge.

8.2 Calculation

8.2.1 Calculate separate;y the percentage of dimensional change (due to felting) for each pair of marks in the direction of wales and courses by the following formula:

$$S_t = \frac{b - c}{b} \times 100$$

where

S_t = dimensional change (due to felting), percent;

b = the distance between a pair of marks (along the wales and courses as the case may be) before milling as measured in **7.2.3**; and

c = the distance between the same pair of marks as noted in **8.1.2**.

8.2.2 Calculate the average dimensional change (due to felting) in each direction.

9 SCOURING LOSS

9.1 Test Specimen

Cut the test specimen weighing about 10 g from each sample.

9.2 Procedure

9.2.1 Dry the test specimen to constant mass in the drying over at 105 ± 3°C temperature and determine its mass accurately.

NOTE — Constant mass shall be deemed to have been reached if the difference between the two successive weighings at an interval of 20 minutes is less than 0.05 percent.

9.2.2 Extract the above specimen with a mixture of benzene and methyl alcohol in the proportion of 3:2 in a Soxhlet apparatus for 4 hours at the rate of 5 extractions per hour, by placing the specimen in a thimble and covering it with cotton or wool previously extracted with the above stated mixture of benzene and methyl alcohol. The solvent shall then be distilled off from the extract. Dry the residue to a constant mass (*see* Note under **9.2.1**) at 105 ± 3°C and determine the mass accuraly.

9.3 Calculation

Calculate the scouring loss by the following formula:

$$\text{Scouring loss, percent} = \frac{a}{b} \times 100$$

where

a = mass of the dry residue (*see* **9.2.2**), and

b = mass of the test specimen (*see* **9.2.1**).

SECTION H

TESTS FOR TAPES, WEBBING AND NARROW FABRICS

TESTS FOR MONOAXIALLY ORIENTED HIGH DENSITY POLYETHYLENE OR POLYPROPYLENE TAPES

DETERMINATION OF LINEAR DENSITY, WIDTH, THICKNESS, BREAKING LOAD, TENACITY, EXTENSION AND HEAT SHRINKAGE

(*Source* : IS 6193 : 1971)

1 SCOPE

1.1 This standard prescribes methods for determining the following characteristics of monoaxially oriented high density polyethylene or polypropylene tapes.

a) Linear density;

b) Width;

c) Thickness;

d) Breaking load, tenacity and extension; and

e) Heat shrinkage.

2 SAMPLING

2.1 Lot

In any consignment the polyethylene or polypropylene tapes of the same width shall be grouped together to constitute a lot.

2.1.1 Unless otherwise agreed to between the buyer and the seller the number of packages of tapes to be selected from a lot shall be as given below. These packages shall be selected at random and to ensure randomness of selection IS : 4905-1968 may be used.

Lot Size	*Sample Size*
Up to 150	5
151 to 500	8
501 to 3 000	13
3 001 and above	20

2.2 The number of packages selected according to **2.1.1** shall be examined for all the characteristics. The lot shall be considered in conformity with the requirements of the relevant specification if the specimens drawn from all the packages satisfy the relevant requirements.

3 ATMOSPHERIC CONDITIONS FOR TESTING

The tests shall be carried out at a temperature of 27 ± 2°C and at 65 ± 2 percent relative humidity.

4 CONDITIONING OF TEST SPECIMENS

Prior to test the test specimens shall be conditioned in the atmosphere given in 3 above for at least 24 hours. Where it is not possible to carry out tests in the above atmosphere, the tests shall be carried out immediately after removal from the conditioned atmosphere.

NOTE – Certain properties, particularly tensile measurements vary to the ageing of the specimen. Where it is considered essential to determine the ultimate values, the test specimens should be aged for at least 7 days after manufacture prior to testing.

5 TEST METHODS

5.1 Linear Density

The linear density of tape shall be determined in accordance with the method prescribed in IS 1226 : 1957.

5.2 Width

The width of the tape shall be determined by measuring with a steel rule having 0.1 mm divisions. The width shall be measured to the nearest 0.1 mm. The average of 10 readings shall be taken over a length of not less than 2 m and reported as the mean width of the tape.

5.3 Thickness

The thickness of the tape shall be determined by means of suitably calibrated spring-loaded dial micrometer. The thickness shall be measured to an accuracy of 2µm. The pressure applied by the contact foot of the dial micrometer shall be not less than 140 kN/m^2 (0.010 15 kgf/cm^2). Ten readings shall be taken over a length of not less than 2 m at regular intervals and the mean reported as the thickness of the tape. A tolerance of ± 5 percent on the mean value shall be permissible.

5.4 Breaking Load, Tenacity and Extension

5.4.1 The breaking load and extension of the tape shall be determined by using a constant-rate-of-extension machine with a test length of 500 mm between the grips in accordance with IS 1670 : 1960.

5.4.2 The tenacity of the tape shall be computed by dividing breaking load in grams by linear density in tex.

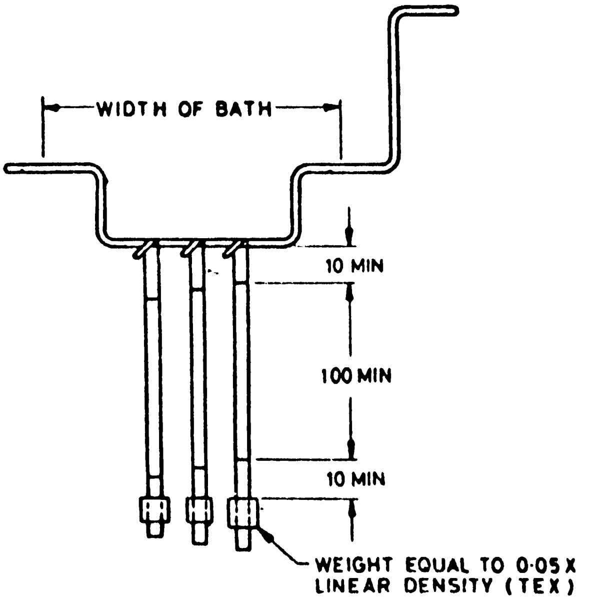
5.5 Heat Shrinkage

5.5.1 *Apparatus*

a) A water-bath sufficiently deep for the specimen to be fully immersed and capable of being controlled at a temperature of 95 ± 0.5°C.

b) A specimen holder to enable the specimens to be fully immersed. A piece of heavy gauge wire bent to a suitable shape (*see* Fig. 1) is convenient.

c) A supply of lead in wire or sheet form for fashioning weights to apply tension to the specimens.



All dimensions in millemetres.

FIG. 1 APPARATUS FOR HEAT SHRINKAGE

5.5.2 Test Specimens

Five specimens each about 150 mm long are required.

5.5.3 Procedure

The linear density of the tape is first determined according to 5.1 Lead weights are prepared, each having a mass in grams equal to 0.05 times the linear density value in tex (or 0.006 times the linear density value in denier). One end of each specimen is tied to the specimen holder and one of the prepared weights is attached to the other. Two marks are made on each tape such that:

a) the distance between the marks is at least 100 mm,

b) the distance from the top mark to the specimen holder is at least 10 mm, and

c) the distance from the bottom mark to the points of attachment of the weight is at least 10 mm (*see* Fig. 1).

With the specimen holder clamped, so that the specimens are hanging vertically under tension imposed by the attached weights, the distance between the insides of the 2 marks is measured to an accuracy of ± 0.5 mm. The specimens are then totally immersed in water for 10 minutes. The bath shall be of such a depth that the weights are supported only by the tape, that is, the weights shall not be allowed to rest on the bottom of the bath. On removal from the bath, the tapes are laid horizontally on absorbent paper and allowed to cool for 10 minutes. Surplus water is wiped off from the tapes; the specimen holder is reclamped so that the tapes again hang vertically and the distance between the 2 marks is re-measured.

5.5.4 Results

Express the shrinkage as a percentage shrinkage at the temperature at which the test was carried out. Percentage shrinkage is defined by the following formula:

$$\text{Percentage shrinkage} = \frac{\text{original length} - \text{final length}}{\text{original length}} \times 100$$

SECTION J

TESTS FOR TEXTILE MATERIALS FOR AEROSPACE PURPOSES

TESTS FOR DOPE FINISHED MERCERIZED COTTON FABRICS FOR COVERING AIRCRAFTS AND GLIDERS DETERMINATION OF DOPING PROPERTIES

(*Source* : IS 514 : 1978]

1 SCOPE

1.1 This standard prescribes the method of test for determination of doping properties of dope finished mercerized cotton fabrics for covering aircrafts and gliders.

2 TEST FRAME

2.1 The test frame should be strong rectangular wooden frame reinforced with metal to prevent warping. It shall be measuring 25 × 25 cm internally and have 2 holes, 5 cm in diameter, bored through one of the sides. A piece of 13 mm thick plywood consisting of 5 piles with a central hole 25 mm in diameter, shall be screwed to one face (*see* Fig. 1). The frame shall be covered on the plywood face with linen fabric under a tension of approximately 360 gf/cm width in the warp direction and 180 gf/cm width in the weft direction.

3 CONDITIONING

Condition the test specimens for the stipulated time, in the standard atmosphere (65 ± 2 percent relative humidity and temperature of 27 ± 2°C).

4 RESISTANCE TO HIGH TEMPERATURE

4.1 The number of test specimens should be one for each tautening dope included in the doping scheme in addition to the one for complete doping scheme.

4.2 Procedure

Apply tautening dope uniformly on each of the test specimens held on individual test frames (*see* 2.1) to impart the coating mass of 120 ± 15 g/m^2 when measured after drying to constant tautening with both the fabric surfaces freely exposed to air.

4.2.1 Apply the complete doping scheme (*see* Table 1) to the test specimen meant for it.

4.2.2 Cut a strip 15 × 2.5 cm *Min* in the warp direction from each of the doped test specimens and heat it for 4 days (96 hours, *Min*) at a temperature of 95°C *Min*, cool to room temperature and bend it along weft around a mandrel moving the strip through minimum of 15 cm over it during bending operation. The diameter of the mandrel shall be 3.2 mm in the case of black finish and 1.6 mm in other cases.

4.3 There shall not be any sign of cracking of the dope film (s).

5 RESISTANCE TO NATURAL WEATHERING

5.1 There should be only one specimen for this test protected at the back of the frame with a covering of waterproof material.

5.2 Procedure

5.2.1 Freely expose the frame to maximum sunlight in the open for 6 months including at least 2 months from the period May to August.

5.2.2 During exposure period examine the frame at least once a day for adhesion of dope, cracks, etc, and its behaviour in dry and wet weather. Also examine tautness once a week.

5.2.3 After exposure for 6 months cut from the fabric in the warp direction, 6 test specimen 2.5 cm wide and sufficiently long to allow 20 cm between the jaws of a suitable testing machine, condition them for 18 hours in standard atmosphere and then determine the tensile strength. Also determine, by the same method and under the same atmospheric conditions, the tensile strength of a piece of untreated fabric cut from the same length of fabric which was held on frame.

5.3 There shall be no cracking, clipping, flaking or blistering of the film, slight chalking being disregarded. The change in colour shall not be too apparent and the underlying coats shall not be visible through final finishing colour. The breaking strength and tautness shall not be impaired.

6 TAUTNESS PROPERTIES

6.1 The number of test specimens is one for each of the tautening dopes included in the doping scheme.

6.2 Procedure

6.2.1 Apply each tautening dope uniformly to the individual test specimen held on the frame to impart it a coating mass of 120 ± 15 g/m^2 measured after drying to constant tautness, both the surfaces of the fabric freely exposed to air.

6.2.2 Measure tautness by any approved method; however, in case of dispute the following reference method shall be used:

> After conditioning the test specimen in the standard atmosphere for 2 hours, *Min*, fit the frame with an air-tight back in a conditioned room. Connect it, through the holes at its side, to a suitable manometer and a water pump, adjusted to reduce the air pressure inside the frame by 5 cm H_2O, including a large air reservoir to smooth out variations in the pressure. Measure the resulting depression (*d*) of the centre of the circle of unsupported fabric, using any instrument accurate to read in 0.025 mm units and that does not impose a load exceeding 5 g on the area of unsupported fabric.

The tautness (T) in the doped fabric is given by the equation:

$$T = \frac{2}{d} \ kgf/cm^2$$

where d is depression read in millimetres.

6.2.3 Determine the mass of added dope by the following method:

Cut minimum area of 250 cm^2 from the circle of unsupported doped fabric. Weigh it, remove the dope by suitable solvents and weigh it again. Record the difference in mass (A). Cut a piece of undoped fabric of the same area from the same length as was used to cover the test frame. Weigh it, apply the same solvent treatment as before under the same atmospheric conditions and weigh it again. Record the difference in mass (B); apply (B) as a correction to (A) and calculate the mass in g/m^2 of the dope.

6.3 The tautness acquired by the mercerized fabric shall be 0.002 to 0.003 kgf/cm^2 per g/m^2 of the dope in case of low doping and 0.003 to 0.004 kgf/cm^2 per g/m^2 of the dope for medium and light doping.

NOTE — Generally the tautness is measured in kgf/cm^2 and dope in oz/yd^2. In that case the ratio between tautness and dope is 1.0 to 1.4 and 1.4 to 1.8 for light, and medium and high dopes respectively.

7 FREEDOM FROM FILM DEFECT

7.1 Testing Atmosphere

The test shall be conducted at:

a) Relative humidity of 65-70 percent,

b) Temperature of 25-29°C, and

c) Air speed of 1 m/s.

7.2 Procedure

7.2.1 Condition test frames, samples of the dopes and finishes to be tested, and the brushes to be used for application in the testing atmosphere in **7.1** for 2 hours, *Min*.

7.2.2 Dope the fabric with the materials as follows:

a) Apply by brush application, one full coat of each tautening dope included in the doping scheme to an individual test piece.

b) When testing non-tautening finishes, apply one full coat of the finish, thinning where appropriate, to a test piece previously tautened with the doping scheme in accordance with Table 1.

7.2.3 Allow to dry under the test conditions and then examine visually.

7.3 The dopes shall be free from blushing, wrinkling, gubbling, etc.

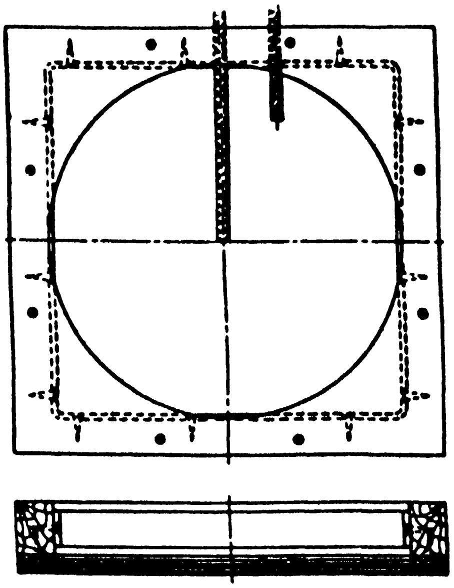


FIG.1 TEST FRAME FOR DOPING TESTS

Table 1 Doping Specifications

(*Clause* 4.2.1)

Description of Components	Tautness					
	Low		Medium		High	
	Dry mass	Normal number of coats	Dry mass	Normal number of coats	Dry mass	Normal number of coats
(1)	(2)	(3)	(4)	(5)	(6)	(7)
For all finishes other than aluminium	g/m^2		g/m^2		g/m^2	
Red oxide tautening dope	-	-	68.0 ± 13.5	3	25.5 ± 5.0	1
Transparent tautening dope	68.0 ± 13.5	3 or 4	-	-	161.0 ± 32.0	6 or 7
Aluminium non-tautening finish	34.0 ± 7.0	2	-	-	-	-
Aluminium tautening dope	-	-	34.0 ± 7.0	2	34.0 ± 7.0	2
Pigmented non-tautening finish (Note 1)	34.0 ± 7.0	1 or 2	34.0 ± 7.0	1 or 2	34.0 ± 7.0	1 or 2
Transparent non-tautening finish (Note 2)	34.0 ± 7.0	1 or 2	34.0 ± 7.0	1 or 2	34.0 ± 7.0	1 or 2
For an aluminium finish						
Red oxide tautening dope	-	-	102.0 ± 20.5	4	25.5 ± 5.0	1
Transparent tautening dope	68.0 ± 13.5	3 or 4	-	-	195.0 ± 39.0	8
Aluminium non-tautening finish	34.0 ± 7.0	2	34.0 ± 7.0	2	34.0 ± 7.0	2
Transparent non-tautening finish (Note 2)	34.0 ± 7.0	1 or 2	34.0 ± 7.0	1 or 2	34.70 ± 7.0	1 or 2

NOTES

1 Four colour and finish matching purposes only, a mass addition of not more than 68 g/m^2 shall be permitted for yellow, white and sky blue finishers.

2 Only when a glossy finish is required.

TESTS FOR FLAX WEBBING FOR AERONAUTICAL PURPOSES DETERMINATION OF MASS, ALKALI SOLUBLE MATTER AND RESISTANCE TO COMBUSTION

(*Source* : IS 2198 : 1971)

1 SCOPE

1.1 This standard prescribes the methods of tests for determination of mass, alkali soluble matter and resistance to combustion of flax webbing for aeronautical purposes.

2 METHOD FOR DETERMINATION OF MASS PER 100 m

2.1 Test Specimens

2.1.1 Cut a piece of webbing approximately 4 m in length from each of the rolls constituting the sample under test.

2.2 Conditioning of Test Specimen

2.2.1 Prior to test, the test specimen shall be conditioned in a standard atmosphere at 65 ± 2 percent relative humidity and 27 ± 2°C temperature.

2.3 Procedure

2.3.1 Take a test specimen and apply a tension equal to one percent minimum breaking load of the webbing (*see* Note). After 60 ± 5 seconds, place 2 marks on the webbing at a distance 3 m apart.

NOTE – The tension may be applied in a breaking load testing machine. It may also be applied by fixing one end of the webbing to a peg and passing the webbing around a pulley and hanging the desired load at the other end.

2.3.2 Release the load, cut the test specimen at the marks and determine its mass to the nearest gram.

2.3.3 Calculate the mass of the webbing per 100 m by the following formula:

$$M = \frac{M_1}{3} \times \frac{100}{1\,000}$$

where

M = mass in kg 100 m, of the webbing and

M_1 = mass in g of 3 m length of the webbing.

3 METHOD FOR DETERMINATION OF ALKALI SOLUBLE MATTER

3.1 Test Specimens

3.1.1 For the purpose of this test approximately 10 g of warp and weft threads of flax webbing, taken from each roll in the test sample, shall constitute the test specimens.

3.2 Apparatus

3.2.1 *Buchner Funnel*

about 15 cm dia.

3.2.2 *Reflux Condenser*

3.3 Reagents

3.3.0 *Quality of Reagents*

Unless otherwise specified, pure chemicals shall be employed in tests and distilled water shall be used where the use of water or distilled water as a reagent is intended.

NOTE – 'Pure chemicals' shall mean chemicals that do not contain impurities which affect the experimental results.

3.3.1 *Sodium Carbonate* — anhydrous.

3.4 Procedure

3.4.1 Divide one test specimen into three approximately equal portions. Weigh them separately in dry stoppered weighing bottles. Take 250 ml of a five percent solution of anhydrous sodium carbonate in distilled water, in a 500-ml conical flask fitted with a reflux condenser and bring to boil. Add the first portion of the test specimen kept in one of the weighing bottles to the boiling solution and continue the boiling gently for two and a half hours. Pour out the liquid and filter it through a hardened filter paper on a Buchner funnel. Wash the test specimen four times by decantation with 200 ml of hot distilled water and filter the washings through the filter. Transfer the test specimen to the filter. Wash three times with 200 ml of distilled water and dry in a water heated oven at 98° C for about an hour. Transfer the test specimen along with any fragment of fibre detachable from the filter paper to the weighing bottle and dry to constant weight in an oven at 105 to 110°C.

3.4.2 Treat the second portion of the test specimen in the same way as the first portion excepting that distilled water shall be used instead of sodium carbonate solution.

3.4.3 Dry the third portion to constant weight in an oven at 105 to 110°C.

3.4.4 Calculate the percentage loss in weight produced by the carbonate boil and distilled water boil on the basis of oven dry weight. The difference between these two is the percentage alkali soluble matter of the test specimen.

3.4.5 Determine similarl the alkali soluble matter of the remaining test specimens.

4 METHOD OF TESTING RESISTANCE TO COMBUSTION

4.1 Test Specimens

4.1.1 For the purpose of this test, a piece of webbing of approximately 40 cm in length, cut from each roll constituting the test sample shall constitute the test specimen.

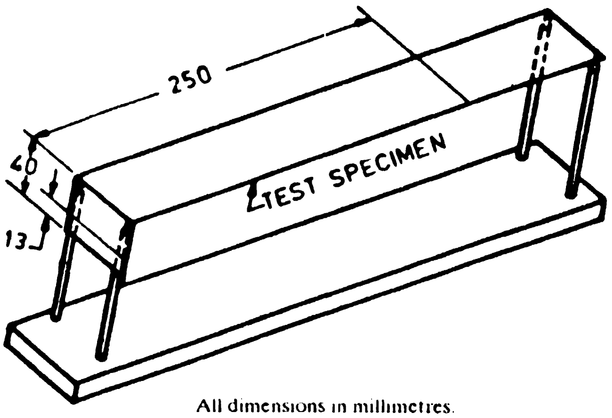
4.1.2 Subject the test specimens to a suitable washing treatment such as dry cleaning or soap washing. Dry the test specimens thoroughly.

4.1.3 Mark two lines on one of the test specimens drawn as in 4.1.1 and conditioned as in 2.2.1, the first approximately 13 mm and the second 40 mm away from one end of the test specimen. Mark accurately a third line on the test specimen 250 mm away from the second line. Support the test specimen on a metal frame in a horizontal position as shown in Fig. 1, leaving the end marked with the two lines free for the purpose of ignition. Ignite the free end by using a gas burner of internal diameter 10 mm with the air supply completely cut off and adjusted to a luminous flame of about 40 mm height; the gas burner should be held in such a position that the base of the flame is 20 mm below the middle of the lower edge of the specimen. Note the time taken for igniting the test specimen and to burn it from the second to the third line of part thereof. Calculate the burning rate per minute.

NOTES

1 The test shall be carried out in a draught free room.

2 The 13 mm length marked on the test specimen is for the purpose of ignition. The test specimen should burn up to the second line in it (that is, 40 mm from the end) before noting the burning time.



All dimensions in millimetres.

FIG. 1 METAL FRAME FOR FLAME TEST

4.1.4 Repeat the test with the remaining test specimens.

4.1.5 Report the lot to be in conformity with the requirements of the standard if the test specimens do not support combustion after the igniting flame is applied for 15 seconds, or if the average burning rate over the 250-mm length, or part thereof, is not more than 100 mm/min, or if the flame extinguishes itself and any subsequent burning without a flame does not extend into undamaged areas.

TESTS FOR COTTON WEBBING, STATICHUTE DETERMINATION OF WIDTH, MASS PER 100 METRES, WATER SOLUBLES AND LENGTH OF ROLL

(*Source* : IS 3244 : 1965)

1 SCOPE

This standard prescribes the methods of tests for determination of width, mass per 100 metres, water solubles and length of roll of cotton webbing, statitute.

2 METHOD FOR DETERMINATION OF WIDTH OF THE WEBBING

2.1 Test Specimen

2.1.1 For the purpose of this test, all the rolls in the test sample shall constitute the test specimens.

2.2 Procedure

2.2.1 Unroll one test specimen and lay a portion of it on a horizontal surface and smooth it out with no greater tension than is necessary to make it lie straight and flat.

2.2.2 Measure to an accuracy of 1 mm, the width of the webbing by means of a graduated steel scale placed at right angles to the selvedges.

2.2.3 Determine similarly the width of the webbing at 5 different places uniformly distributed along the length of the roll. Calculate the mean of the 5 test values.

2.2.4 Repeat the test with the remaining test specimens.

2.3 Report

2.3.1 Report the lot to be in conformity with the relevant requirement, if the number of rolls whose width varies from the relevant value specified by more than the tolerance prescribed in the specification is not more than the corresponding number given in the specification.

3 METHOD FOR DETERMINATION OF MASS PER 100 METRES

3.1 Test Specimens

3.1.1 Cut a piece of webbing approximately 4 m in length from each of the rolls constituting the sample under test.

3.2 Conditioning of Test Specimens

3.2.1 Prior to test, the test specimens shall be conditioned in a standard atmosphere at 65 ± 2 percent relative humidity and 27 ± 2°C temperature.

3.3 Procedure

3.3.1 Take a test specimen and apply a tension equal to one percent of the minimum breaking load of the webbing (*see* Note). After 60 ± 5 seconds, place two marks on the webbing at a distance of 3 m apart.

NOTE — The tension may be applied in a breaking load testing machine; it may also be applied by fixing one end of the webbing to a peg and passing the webbing around a pulley and hanging the desired load at the other end

3.3.2 Release the load and cut the test specimen at the marks, and determine its mass to the nearest gram.

3.3.3 Calculate the weight of the webbing per 100 m by the following formula:

$$M = \frac{M_1}{3} \times 100$$

where

M = mass of 100 m of the webbing, and

M_1 = mass of 3 m length of the webbing (*see* 3.3.2).

3.3.4 Repeat the test with the remaining test specimens (*see* 3.1.1).

3.4 Report

3.4.1 Report the lot to be in conformity with the relevant requirement, if the condition prescribed in the specification is satisfied.

4 METHOD FOR DETERMINATION OF WATER SOLUBLES

4.1 Test Specimens

4.1.1 Cut one test specimen weighing approximately 10 g from each roll constituting the sample under test.

4.2 Conditioning of Test Specimens

4.2.1 Prior to test, the test specimens shall be conditioned in standard atmosphere at 65 ± 2 percent relative humidity and 27°C ± 2°C temperature.

4.3 Procedure

4.3.1 Weigh one test specimen, conditioned as prescribed in 3.2, correct to the nearest 0.001 g. Cut the test specimen into small pieces, and boil the pieces in 200 ml of distilled water in a beaker for half an hour and filter into a 500-ml measuring flask. Extract the test specimen twice again, using 100 ml of distilled water each time and boiling for 15 minutes, and filter the aqueous extracts into the same flask. Pour the solution into a beaker and concentrate it to a small volume. Then transfer it to a basin of known mass, washing the beaker with a little distilled water. Evaporate the contents of the basin on a steam-bath and dry to constant weight in an air-oven maintained at 105 to 110°C. Determine the mass of the residue.

4.3.2 Calculate the percentage of water solubles by the following formula:

$$\text{Water solubles, percent} = \frac{M_1 \times 100}{M_2}$$

where

M_1 = mass of the residue, and

M_2 = mass of the test specimen

4.3.3 Repeat the test with the remaining test specimens.

4.4 Report

Report the lot to be in conformity with the requirements of the specification, if the test values satisfy the conditions prescribed in the criteria for conformity.

5 METHOD FOR DETERMINATION OF LENGTH OF ROLL

5.1 Test Specimens

For the purpose of this test, all the rolls in the test sample shall constitute the test specimens.

5.2 Equipment

A flat table little over 5 m long having a smooth horizontal surface with markings in metres and centimetres on one side shall be used.

5.3 Procedure

5.3.1 Unroll one test specimen and draw one of its ends across the full length of the table and smoothen the portion of the webbing on the table with no greater tension than is necessary to make it lie straight and flat.

5.3.2 Mark on the webbing the first 5 m length as measured against the mark on the table. Measure the entire length in 5 m lengths till a length less than 5 m remains. Measure this length correct to a centimetre in metres and centimetres against the markings on the table.

5.3.3 Compare the value obtained as in 5.3.2 with the declared or marked length of the roll and note the deficiency in length, if any.

5.3.4 Repeat the test with the remaining test specimens and calculate the mean percentage deficiency in length, if any.

TESTS FOR NYLON SEWING THREADS FOR AEROSPACE PURPOSES DETERMINATION OF PERFORMANCE OF NYLON SEWING THREADS

(*Source* : IS 4229 : 1978)

1 SCOPE

1.1 This standard prescribes a test method for determination of performance of nylon sewing threads for stitching aerospace textile materials.

2 PERFORMANCE OF TEST FOR LIGHT SEWING THREADS

2.1 Test Specimen

The test specimen shall consist of four full-width lengths, each approximately 1 m long, of nylon fabric.

2.2 Apparatus

A twin-needle lock stitch sewing machine capable of stitching at the rate of 3 250 ± 250 stitches per minute, maintaining 32 stitches/dm, properly adjusted for tension, 8 mm gauge, and fitted with an appropriate size of needle, shall be used.

2.3 Procedure

2.3.1 Stitch the test piece, as shown in Fig. 1, lifting the foot and needle (but not cutting the thread) at the end of each straight run to enable the test piece to be turned. Ignore any slight looping at each corner.

2.3.2 The nylon threads of linear density of less than 100 tex shall complete the stitching pattern, shown in Fig. 1, when tested as above, without slipped or broken stitches, the mal-formed stitches not exceeding two.

3 PERFORMANCE TEST FOR HEAVY SEWING THREADS

3.1 Test Specimens

3.1.1 Four test specimens of dyed nylon webbing shall be tested. Each specimen shall consist of the layers of webbing, approximately 50 mm wide and 0.5 m long as given below:

a) For threads of varieties No. H1, H2 and H3	2 layers
b) For threads of varieties No. H4 and H5	3 layers

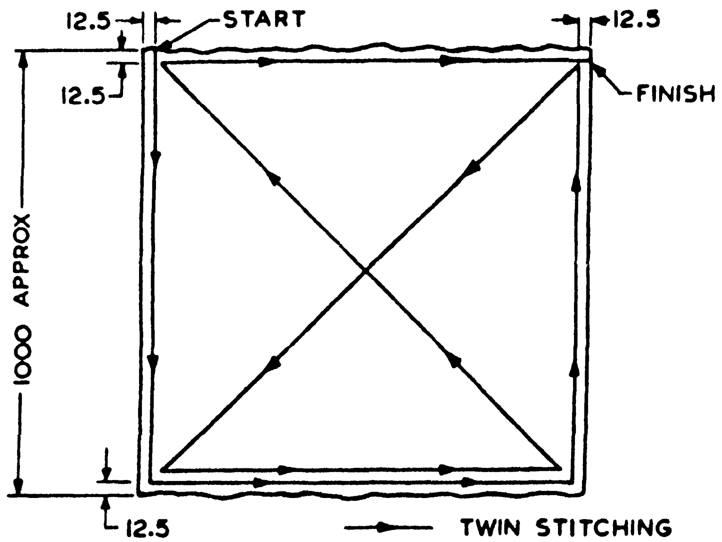
3.2 Apparatus

A single-needle lock stitch sewing machine, capable of stitching at the rate of 250 ± 40 stitches per minute, maintaining 20 stitches/dm, properly adjusted for tension and fitted with an appropriate size of needle shall be used. Application of lubricant to the needle is permitted.

3.3 Procedure

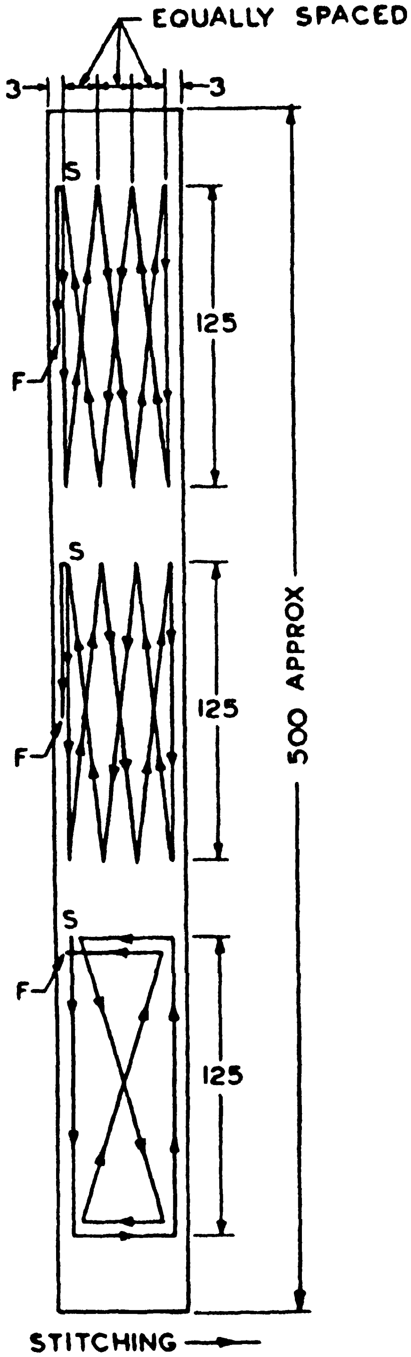
3.3.1 Stitch together the webbings of each test piece with two four-point double W's and a gate pattern, as shown in Fig. 2.

3.3.2 The nylon sewing threads of linear density more than 100 tex shall complete the stitching pattern shown in Fig. 2, when tested as above, without slipped or broken stitches, the mal-formed stitches not exceeding two.



All dimensions in millimetres.

FIG. 1 TEST PIECE FOR LIGHT SEWING THREADS



All dimensions in millimetres.

FIG. 2 TEST PIECE FOR HEAVY SEWING THREADS

TEST FOR WIRE-WOVEN RAYON FABRIC FOR AEROSPACE PURPOSES
DETERMINATION OF COEFFICIENT OF RADAR REFLECTION

(*Source* : IS 4719 : 1984)

1 SCOPE

This standard prescribes the method of test for determination of coefficient of radar reflection of wire-woven rayon fabric for aerospace purposes.

2 DETERMINATION OF COEFFICIENT OF RADAR REFLECTION

2.1 Test Specimen

2.1.1 Cut a square piece of the wire-woven rayon fabric of size 660 × 660 mm and fix it to a wooden frame as shown in Fig. 1.

2.2 Procedure

2.2.1 Mount a duralumin sheet on a stand facing a transmitter and a voltmeter as shown in Fig. 1.

2.2.2 Adjust the power level with the help of a signal generator output control to read a convenient reading on the voltmeter, say 100 mV, by subjecting the mW energy on the duralumin sheet used as a reference plane of reflection that is 100 percent in the set-up, which is the incident voltage.

2.2.3 Replace the duralumin sheet by the fabric under test and record the voltage , which is the reflected voltage.

2.3 Calculation and Reporting

2.3.1 Calculate as follows the coefficient of radar reflection on both S- and X- band frequencies separately and report as coefficient of radar reflection at that frequency:

$$\text{Coefficiency of radar reflection} = \frac{\text{reflected voltage}}{\text{incident voltage}} \times 100$$

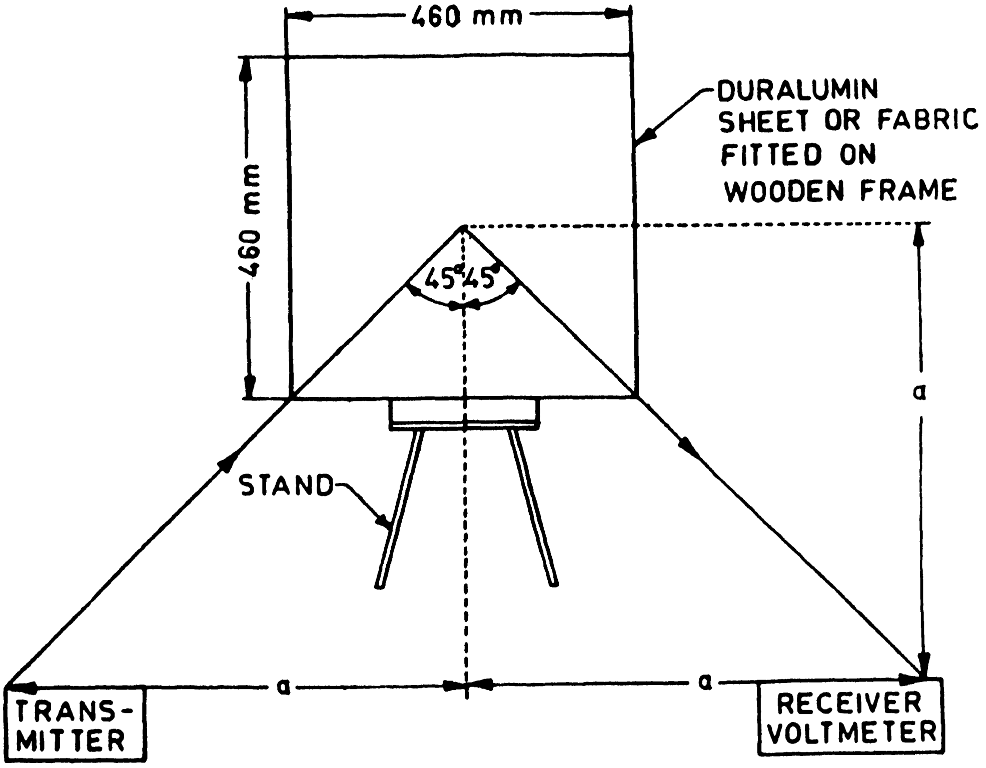


FIG. 2 MEASUREMENT OF RADAR REFLECTION OF WIRE-WOVEN RAYON FABRIC

TESTS FOR NYLON WEBBING FOR AERONAUTICAL PURPOSES DETERMINATION OF WEIGHT PER METRE, WIDTH, LENGTH, ACCELERATED AGEING OF IMPREGNATED WEBBING, WEIGHT OF RESIN DEPOSITION AND RESISTANCE TO ABRASION

(*Source:* IS 4727 : 1968)

1 SCOPE

This standard prescribes the methods of tests for determination of weight per metre, width, length, accelerated ageing of impregnated webbing, weight of resin deposition and resistance to abrasion of nylon webbing for aeronautical purposes.

2 METHOD FOR DETERMINATION OF MASS PER METRE

2.1 Test Specimens

2.1.1 Cut a piece of webbing approximately 4 m in length from each of the rolls constituting the sample under test.

2.2 Conditioning of Test Specimens

2.2.1 Prior to test, the test specimen shall be conditioned in a standard atmosphere at 65 ± 2 percent RH and 27 ± 2°C temperature.

2.3 Procedure

2.3.1 Take a test specimen and apply a tension equal to 1 percent of the minimum breaking load of the webbing. After 60 ± 5 seconds, mark in the length in tension two separate 1 m specimens at the marks and determine the mass of each specimen to the nearest gram.

2.3.2 Repeat the test with the remaining test specimens.

3 METHOD FOR DETERMINATION OF WIDTH OF THE WEBBING

3.1 Test Specimens

3.1.1 For the purpose of this test, all the rolls in the test sample shall constitute the test specimens.

3.2 Procedure

3.2.1 Unroll one test specimen and lay a portion of it on a horizontal surface and smooth it out with no greater tension that is necessary to make it lie straight and flat.

3.2.2 Measure to an accuracy of 1 mm, the width of the webbing by means of a graduated steel scale placed at right angles to the selvedges.

3.2.3 Determine similarly the width of the webbing at 5 different places uniformly distributed along the length of the roll. Calculate the mean of the 5 test values.

3.2.4 Repeat the test with the remaining test specimens.

4 METHOD FOR DETERMINATION OF LENGTH OF ROLL

4.1 Test Specimens

For the purpose of this test, all the rolls in the test sample shall constitute the test specimens.

4.2 Equipment

A flat table little over 5 m long having a smooth horizontal surface with markings in metres and centimetres on one side shall be used.

4.3 Procedure

4.3.1 Unroll one test specimen and draw one of its ends across the full length of the table and smoothen the portion of the webbing on the table with no greater tension that is necessary to make it lie straight and flat.

4.3.2 Mark on the webbing the first 5 m length as measured against the mark on the table. Measure the entire length in 5 m lengths till a length less than 5 m remains. Measure this length correct to a centimetre in metres and centimetres against the markings on the table.

4.3.3 Compare the value obtained as in 4.3.2 with the declared or marked length of the roll and note the deficiency in length, if any.

4.3.4 Repeat the test with the remaining test specimens and calculate the mean percentage deficiency in length, if any.

5 METHOD FOR ACCELERATED AGEING OF IMPREGNATED WEBBING

5.1 Test Specimen

For the purpose of this test, all the impregnated webbing rolls in the sample shall constitute the test specimen.

5.2 Equipment

An accelerated weathering unit consisting essentially of the following features.

a) Vertical carbon arc mounted at the centre of a vertical cylinder. The arc shall be designed to accommodate either 2 or 3 pairs of carbon but shall burn only 1 pair at a time automatically transferring from one pair to another as the carbons are consumed. The arc shall be operated on 60A and 50V across the arc for ac and on 50A and 60V across the arc for dc.

b) The arc shall be surrounded by removable panels (or filters) having good absorbing or transmitting properties.

c) A rotating rack with holders in which the specimens shall be placed side by side and exposed to radiation from the arc with the centre of the face of the specimen at a radial distance of approximately 45 cm from the arc. The rack shall rotate about the arc at a uniform speed of about 1 revolution per 2 hours.

d) Water spray nozzles mounted horizontally in the test chamber inside the specimen rack and so placed that water shall strike the specimens evenly over the entire length in the form of a fine spray in sufficient volume to cover the specimens immediately on impact. The apparatus shall be operated so that the specimens are exposed to successive cycles of 102 minutes of light without spray followed by 18 minutes of light with spray.

e) Means for maintaining the required temperature of water in the spray, namely, 26.7 ± 5.6°C.

f) Means for maintaining the required pressure of water entering the spray, namely, 0.844 to 1.265 kg/cm^2.

g) Means for delivering the required quantity of water per spray nozzle to the specimen, namely, 0.5 to 1 l/h per spray nozzle.

h) Means for maintaining the air temperature within the machine, namely, at 68 ± 5.7°C with the filters in place at the exposure plane of the specimen rack, and at 80 ± 5.7°C when filters are removed; means for measuring the temperature.

5.3 Procedure

Take 5 test specimens of impregnated webbing and 5 specimens of untreated webbing. Place them side by side in the rack arranging in such a way that one impregnated webbing alternates with that of one untreated webbing. The specimens shall be placed 2.5 cm apart. Expose the specimens to carbon arc light source for a total of 100 hours. Remove the test specimen at the end of the exposure period and condition them to standard atmospheric conditions for 24 hours. When the test specimens have been conditioned, test them for breaking load by the method given in Table 1.

6 METHOD FOR DETERMINATION OF WEIGHT OF RESIN DEPOSITION

6.1 Test Specimen

For the purpose of this test, all the impregnated webbing rolls in the test sample shall constitute the test specimen.

6.2 Apparatus/Reagent

6.2.1 *Soxhlet Apparatus*

6.2.2 *Methyl Ethyl Ketone*

6.3 Procedure

6.3.1 Take a test specimen of impregnated webbing and remove from it warp and weft yarn so that the yarns weigh about 5 g. Dry the sample to constant weight in a weighing bottle at a temperature of 104 ± 4.5°C. Extract the test specimen with methyl ethyl ketone in a soxhlet apparatus for 6 hours. Determine the final weight of the extracted specimen after constant weight has been obtained under the same drying conditions as mentioned above.

6.3.2 Calculate the percentage weight of resin deposit by the following formula:

$$\text{Percentage of weight of resin deposit} = \frac{\text{loss in weight on extraction}}{\text{dry weight of sample}} \times 100$$

6.3.3 Repeat the test with the remaining test specimens.

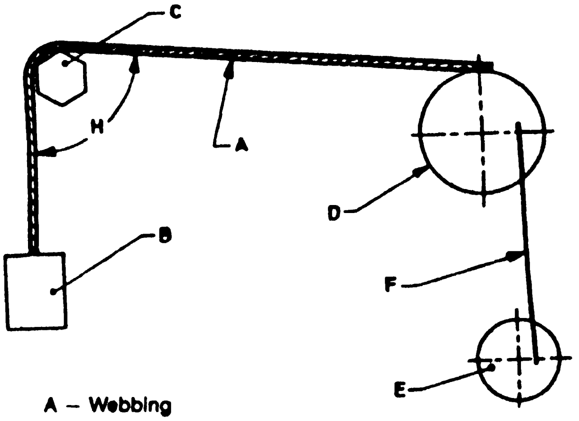
7 METHOD FOR DETERMINATION OF RESISTANCE TO ABRASION

7.1 Test Specimens

For the purpose of this test, all the impregnated webbing rolls in the test sample shall constitute the test specimen.

7.2 Equipment

A device as illustrated schematically in Fig. 1.



A – Webbing

B – Weight, 2.4 ± 0.06 kg

C – Hexagonal rod 6.35 A/F, cold rolled, 97 to 101 RHB

D – Drum 400 mm dia

E – Crank

F – Connecting rod

H – Angle formed by webbing 85 ± 2o

FIG. 1 SCHEMATIC DIAGRAM OF ABRASION RESISTANCE TESTING DEVICE

7.3 Procedure

7.3.1 Take one test specimen of impregnated webbing *A* and attach weight *B* to one end. Pass the webbing over the hexagonal bar *C* and attach the other end of the webbing to the oscillating drum *D*. Oscillate the drum so that the webbing is given a 30 ± 2.5 cm transverse over the hexagonal bar at the rate of 60 ± 2 strokes/min. In this way, impart 5 000 strokes to the webbing. Remove the webbing on expiry of the last stroke and determine its breaking load.

7.3.2 Repeat the test with the remaining test specimens but changing the edges of the hexagonal bar for each test specimen tested.

TESTS FOR WOVEN GLASS FIBRE FABRICS (LOOM STATE) FOR PLASTIC LAMINATES FOR AEROSPACE PURPOSES DETERMINATION OF MASS PER UNIT AREA AND BREAKING STRENGTH

[*Source* : **IS 5746 (Part 1) : 1987**]

1 SCOPE

This standard prescribes the methods of tests for determination of mass per unit area and breaking strength of woven glass fibre fabrics (loom state) for plastic laminates for aerospace purposes.

2 METHOD FOR DETERMINATION OF THE MASS PER UNIT AREA

2.1 Conditioning

2.1.1 Condition the specimen for not less than 6 hours in an atmosphere of 65 ± 2 percent relative humidity and 27 ± 2°C. Carry out all measurements and weighings without removal of the material from the conditioning atmosphere.

NOTE — It is recognized that within the temperature range 22 to 29°C and the range 48 percent relative humidity to 67 percent relative humidity, the difference in the results of testing will not be significant.

2.2 Procedure

2.2.1 Lay the sample flat and free from applied tension. Cut a specimen as large as is convenient but not less than 30 cm × 30 cm; avoid cutting portions nearer than 2.5 cm from the selvedges.

2.2.2 Measure the dimensions of the specimen to an accuracy of ±1.5 percent and weigh the specimen to an accuracy of ±1.5 percent. Calculate the mass per unit area in g/m^2.

3 METHOD FOR DETERMINATION OF BREAKING STRENGTH

3.1 Specimen Preparation and Conditioning

3.1.1 Cut six specimens not less than 65 mm wide from the test sample in the direction of the warp, and six similar specimens in the direction of the weft. Each specimen shall be 350 ± 50 mm long, and no two specimens cut in the same direction shall contain the same longitudinal threads.

3.1.2 Prepare the ends of each specimen either as in 3.1.4 or 3.1.5. In case of dispute the method given in 3.1.4 shall be used.

3.1.3 Fray each specimen by removing lengthways threads equally from each side of each specimen until the width of the specimen is reduced to 50 mm leaving the cross threads undisturbed.

3.1.4 Lay the specimen, before fraying, on stiff paper and impregnate each end of each specimen with and attached to the paper by a suitable cement, leaving an untreated length of not less than 200 mm in the middle of each specimen. After the cement has dried, remove lengthwise threads equally from each side of each specimen by careful cutting and fraying, until the width of each specimen is reduced to 50 mm in the untreated portion. When the specimen has been fixed in the jaws of the testing machine (*see* 3.2.2) cut the paper across the middle.

NOTE — Examples of suitable cement are:

a) adhesive based on natural rubber or polychloroprene;

b) a solution of polybutylmethacrylate in xylene, and

c) a solution of polymethylmethacrylate moulding powder in diethyl ketone or butanone.

3.1.5 Lay each specimen, already frayed to 50 mm width, on a flat surface with each end laid between two sheets of polyvinyl butyral so as to leave a 20 mm length uncovered at the middle of each specimen. Cover the sheets of polyvinyl butyral with a medium mass paper and apply an electric iron to soften the polyvinyl butyral and cause it to penetrate and adhere to the test specimen.

3.1.6 Condition each specimen prior to testing in an atmosphere of 65 ± 2 percent relative humidity and 27 ± 2°C for not less than 6 hours and test them without removal from that atmosphere (*see* Note under 2.1.1).

3.2 Procedure

3.2.1 Fix each specimen in the jaws of a tensile testing machine so that the unsupported length between the jaws is 200 mm.

3.2.2 Open the jaws of the testing machine until wider than the testing specimen and with edges parallel to each other and at right angles to the direction of pull. Pack the jaws with suitable material such as chamois leather to assist in gripping the specimen without causing damage.

3.2.3 Apply the load to the specimen at a substantially constant rate such that a load equivalent to the minimum specified breaking strength is reached in 60 ± 10 seconds.

3.2.4 Report the average breaking strength of each set of six specimens as the average breaking strength in N per 10 mm width.

TESTS FOR WOVEN GLASS FIBRE FABRICS (DESIZED) FOR PLASTIC LAMINATES FOR AEROSPACE PURPOSES DETERMINATION OF RESIDUAL SIZE CONTENT

[*Source* : IS 5746 (Part 2) : 1987]

Many applications of woven glass fibre fabrics demand fabrics with very low residual size content especially for electrical purposes. Keeping this in view, the test method on residual size content has been prescribed for ensuring its proper determination.

1 INTRODUCTION

1.1 After a preliminary determination of moisture content, the desized glass fabric is heated so as to ignite any residual size. Since the experimental results depend in differential weighing and as the change in mass is very small, special care is necessary, particularly to prevent access of moisture to the specimen before each weighing.

2 APPARATUS

2.1 Weighing Bottle

Approximate diameter 50 mm.

2.2 Desiccator

Charged with phosphorous pentoxide.

2.3 Combustion Apparatus

(*See* Fig. 1).

2.4 Balance

Accurate to 0.000 1 g.

2.5 Drying Oven

2.6 Nickel-Silver Boat

Approximate dimensions 90 mm x 35 mm x 20 mm.

3 PROCEDURE

3.1 From a rectangular specimen of the desized fabric of mass approximately 4 g, fray out five threads from each side so as to leave a fringe. Roll the prepared specimen loosely and tie with a thread of glass yarn taken from the specimen.

3.2 Weigh the prepared specimen accurately in a weighing bottle of previously determined mass and heat in the drying oven for 30 minutes at 105 ± 2°C. Cool in the desiccator and re-weigh.

3.3 Place the dried specimen in a previously dried and weighed nickel-silver boat and transfer to a combustion apparatus having the essential features shown in Fig. 1 and heat at a temperature of 575 ± 25°C.

3.4 After heating for ten minutes, a current of air dried by passage over calcium chloride and then over phosphorous pentoxide shall be drawn through the tube containing the nickel-silver boat and specimen while heating for a further five minutes.

3.5 Quickly transfer the nickel-silver boat containing the specimen to the drying oven which already holds the previously weighed weighing bottle. After the nickel-silver boat has cooled down, transfer this, together with its content to the weighing bottle prior to removing from the drying oven.

3.6 Cool to room temperature in the desiccator and re-weigh.

3.7 Express the loss in mass of the specimen as a percentage of the original dry weight of the specimen.

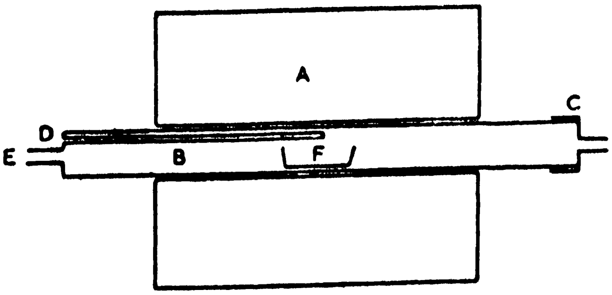
4 REPORT

4.1 The percentage loss in mass of the specimen determined as above shall be rounded off to the first place of decimal and reported as the residual size content.

Example:

Percentages of 0.050 to 0.149 shall be reported as 0.1 percent.

NOTE — Any other suitable method may be used provided it can be shown to give the same results.



A — Electrically heated furnace
B — Combustion tube
C — Air outlet cap (removable)
D — Thermocouple tube
E — Air inlet
F — Nickel-silver boat

FIG. 1 COMBUSTION APPARATUS

TESTS FOR WOVEN GLASS FIBRE FABRICS FOR PLASTIC LAMINATES FOR AEROSPACE PURPOSES – FINISHED FABRICS IN USE WITH POLYESTER RESIN SYSTEM
DETERMINATION OF BREAKING STRENGTH, CROSS BREAKING STRENGTH, DRAPABILITY AND FLEXIBILITY

[*Source* : **IS 5746 (Part 3) : 1987**]

1 SCOPE

This standard prescribes the methods of tests for determination of breaking strength, cross breaking strength, drapability and flexibility of woven glass fibre fabrics for plastic laminates for aerospace purposes (finished fabrics in use with polyester resin system).

2 DETERMINATION OF BREAKING STRENGTH

2.1 Selection of Test Specimen

Six specimens not less than 30 cm long and 6.5 cm wide be cut from the test sample in the direction of warp and six in the direction of weft. No two specimens cut in the same direction shall contain the same longitudinal threads.

2.2 Conditioning of Test Specimens

Prior to testing, the specimens shall be conditioned for not less than 6 hours, in an atmosphere with relative humidity of 65 ± 2 percent and a temperature of 27 ± 2°C and tested under the same conditions.

2.3 Preparation of Test Specimens

2.3.1 *Method 1*

The specimens shall be laid on stiff kraft paper and the ends of the specimens impregnated, coated and attached to papers with polymethyl methacrylate cement (*see* Note), leaving 20 cm length of the specimens untreated at the middle. After the cement has dried, the threads are removed from the sides of the specimen by careful cutting and fraying so as to reduce the width to 5 cm in the untreated portion. When the specimen has been fixed in the jaws of the machine, the paper is cut across at the middle. The 20 cm centre area of the test specimen shall not be distorted or contaminated during the application of the cement. The cement shall thoroughly impregnate the fabric at the points of application so that when dry, the test specimens are securely cemented to the kraft paper at these points. Each specimen shall be fixed in the jaws of testing machine so that the unsupported length is not less than 20 cm. The load is steadily applied at such rate that a load equal to the specified minimum breaking load is reached in approximately one minute.

NOTE – The cement can be prepared by dissolving methyl methacrylate moulding powder in methyl ethyl ketone to produce a liquid solution having the consistency of paint.

2.3.2 *Method 2*

Lay the specimen, already frayed to 50 mm width, on a flat surface with each end between two sheets of polyvinyl butyral and leave 200 mm uncovered at the middle of the specimen. Cover the sheets of polyvinyl butyral with medium weight paper and apply an electric iron to soften the polyvinyl butyral and cause it to penetrate and adhere to the glass fibre.

2.4 Procedure

Carry out the test according to grab method as prescribed in IS 1969 :1985 'Method for determination of breaking load and elongation of woven textile fabrics (*second revision*)'.

3 PREPARATION AND TESTING OF RESIN GLASS FABRIC LAMINATE FOR CROSS-BREAKING STRENGTH

3.1 Principle

A test laminate of 3.2 ± 0.25 mm thickness and 30 × 30 cm is prepared using sufficient number of glass cloth and polyester resin with a suitable catalyst and accelerator. The proportion of resin hardener and accelerator and subsequent curing of the laminate shall be in accordance with the instructions of the resin manufacturer. The glass fabric cut to size shall be dried in a ventilated oven for one hour at 100 ± 5°C, and cooled in a desiccator and used immediately on removal. The fabric is impregnated with the resin to give a final resin content of 35 to 42 percent of the total mass when determined by ignition at 575 ± 25°C. The laminating process shall be done at an ambient temperature of 17 to 28°C.

3.2 Preparation of Polyester Laminate

A suitable method of preparation of polyester laminate is as follows:

> Mass of the resin necessary to give the required resin content is calculated from the mass of glass cloth to be used. A polished metal plate of 40 × 40 cm is covered with a layer of a regenerated cellulose film 0.05 mm thick. A layer of dried glass cloth of suitable size is laid on it. Sufficient amount of catalysed resin is poured on to the centre of the cloth and spread out uniformly with roller or thin metal strip until the cloth is evenly coated. The procedure is repeated with successive layer of the cloth superimposed on the previous end with the warp thread parallel to these in the preceding ply. The whole process should not take more than 20 minutes.
>
> The top layer is then covered with a layer of regenerated cellulose fibre followed by a second polished metal plate. Metal stops 3 mm thick are placed between lower and upper metal plates and

whole build-up is placed between platens of a press and held under a pressure of 35 to 7 kN/m^2 during the curing schedule. The laminate after curing in accordance with resin manufacturer's instructions is postcured at 100°C for 2 hours ensuring that it is free from visible voids and other defects. The laminate is allowed to cool to room temperature.

3.3 Determination of Flexural Strength

3.3.1 *Test Specimen*

Ten rectangular strips each measuring 100 × 15 mm shall be cut with the longer direction parallel to the warp or weft for determining the flexural strength of the strips.

3.3.2 *Conditioning of Test Specimen*

The specimens to be tested in the 'dry condition' shall be conditioned for not less than 24 hours in an atmosphere of 65 ± 2 percent relative humidity and a temperature of 27 ± 2°C prior to testing, and tested under the same condition.

Specimens to be tested in the 'wet condition' shall be immersed in boiling distilled water for two hours and after that the same shall be removed and cooled in distilled water at room temperature. The test shall be conducted on the wet specimens immediately after removal from distilled water.

3.3.3 *Apparatus*

A suitable flexural strength testing machine with a bend jig, which will permit the span being varied to suit the thickness of specimens, is used. The machine shall be properly calibrated and the error, if any, in the load measuring system shall not exceed ± 1 percent of the applied load. The contract surface of the supports and loading blocks shall have a radius of 3.2 ± 0.2 mm and shall not be less than 25 mm in length from each end.

3.3.4 *Measurement of Dimensions*

The width and the thickness at the centre of span shall be measured to the nearest 0.01 mm. The span shall be measured to the nearest 0.2 mm.

3.3.5 *Procedure*

The specimen shall be placed symmetrically over the supports in the bend jig (*see* Fig. 1) which are 50 mm apart (between 16 to 18 times the thickness of specimen). Align the loading block and the supports so that the axes of the cylindrical surfaces are parallel and the loading block is midway between the supports. Apply the load to the specimen at the specified cross-head rate of 5 to 6.5 mm/min till the specimen fractures. The load at fracture shall be noted.

3.3.6 *Calculation and Reporting*

Flexural strength or the modulus of rupture in bending is the maximum load sustained by the specimen converted to maximum fibre stress using the following formula:

$$S = 15 \times \frac{wl}{bt^2}$$

where

S = flexural strength in mN/m^2,

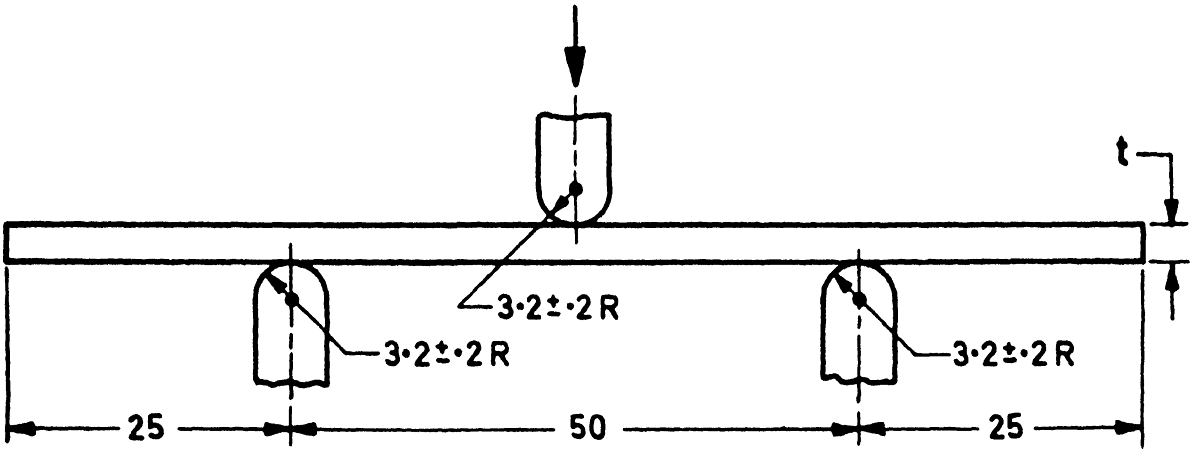
w = load at fracture in N,

l = span in mm,

b = breadth of the specimen in mm, and

t = thickness of specimen in mm.

3.3.6.1 The average of five determination in each direction and tested in each state, that is, dry and wet, shall be reported as the flexural strength.



t — thickness of specimen

All dimensions in millimetres.

FIG. 1. FLEXURAL TEST FOR GLASS FIBRE LAMINATE

4 METHODS OF TEST FOR DRAPABILITY AND FLEXIBILITY

4.1 Drapability (Drape Stiffness)

4.1.1 The method outlines here is a cantilever test suitable for woven fabrics. In this test, a strip of fabric is laid in a direction parallel to its long dimensions, so that its ends project from the edge of the horizontal surface. The length of overhang is measured when the tip of the test specimen is depressed under its own mass to a point where the line joining the tip to the edge of the platform makes an angle of 41.5° with the horizontal. One half of this length is the bending length of the specimen. The cube of this quantity multiplied by the mass per unit area of the fabric is the drape stiffness value.

4.1.2 *Apparatus*

(1) A horizontal platform with a minimum area of 50 × 200 mm having a smooth low friction flat surface together with an indicator inclined at an angle of 41.5° below the plane of the platform surface; (2) a metallic strip of size 25 x 200 mm and of thickness 3 mm; and (3) a levelling bubble.

4.1.3 *Preparation of Test Specimens*

Cut three test specimens of 25 × 200 mm size with the long dimensions parallel to warp and three with the long dimensions parallel to weft. The specimens shall be cut in such a way that no two warp specimens contain the same warp yarns for the warp direction tests and no two weft specimens contain the same weft yarns for the weft direction tests. Avoid selvedges, end pieces and creased or folded places and handle the specimens as little as possible.

4.1.4 *Conditioning of Test Specimen*

Prior to testing, the test specimens shall be conditioned for not less than 6 hours in an atmosphere with relative humidity of 65 ± 2 percent and temperature of 27 ± 2°C.

4.1.5 *Procedure*

4.1.5.1 Set the test platform with the inclination indicator at eye level.

4.1.5.2 Adjust the platform to be horizontal using a levelling bubble.

4.1.5.3 Place a specimen on the platform with the metallic strip on top of it so that the leading edges coincide. Holding the metallic strip in a horizontal plane, slide the specimen and metal strip steadily until the leading edges of the specimen projecting beyond the edge of the platform fall and coincide with the inclination indicator. If the specimen has a tendency to twist, take the reference point at the centre of the loading edge. Discard specimens which twist more than 45°. Read the length of the overhang from the scale to the nearest 1 mm.

4.1.5.4 Take four readings from each specimen with each side up, first at one end and then the other.

4.1.5.5 Determine the mass of the fabric and express in mg/cm^2.

4.1.5.6 Calculate the drape stiffness (G) as follows:

$$G \text{ (mg cm units)} = M \times \frac{(O)^3}{(2)^3}$$

where

M = mass of fabric in mg/cm^2, and

O = length of the overhang measured in cm.

If an overall average figure for the fabric is required, calculate the geometric mean of the average values obtained for warp and weft direction as follows:

$$Go = \sqrt{Gw \times Gf}$$

where

Go = overall drape stiffness,

G_w = warpway drape stiffness, and

Gf = weftway drape stiffness.

NOTE — The test shall be carried out in the standard atmosphere of 65 ± 2 percent relative humidity and 27 ± 2°C temperature.

TESTS FOR MATERIAL (NYLON WEBBING) FOR AIRCRAFT SAFETY BELTS

DETERMINATION OF RESISTANCE TO COLD AND PLIABILITY AND RESISTANCE TO ACCELERATED WEATHERING (OVEN METHOD)

(*Source* : IS 8947 : 1978)

1 SCOPE

1.1 This standard prescribes the methods of tests for determination of resistance to cold and pliability and resistance to accelerated weathering (oven method) of nylon webbing for aircraft safety belts.

2 METHOD FOR DETERMINATION OF RESISTANCE TO COLD AND PLIABILITY

2.1 Test Specimens

For the purpose of this test, all treated webbing rolls in the test sample shall constitute the test specimen.

2.2 Procedure

The specimens shall be 20 cm long. One unaged webbing and another subjected to the accelerated weathering test shall be suspended in a cold chamber, maintained at a temperature of —54 ± 1°C for 4 h ± 15 min. At the end of this period, the specimens, while in the cold chamber shall be flexed manually and their pliability shall be compared with an 'as received' specimen flexed outside the cold chamber at room temperature.

3 METHOD FOR DETERMINATION OF RESISTANCE TO ACCELERATED WEATHERING (OVEN METHOD)

3.1 Test Specimen

For the purpose of this test, all the rolls in the test sample shall constitute the test specimen.

3.2 Procedure

Take a specimen of treated webbing and keep it in an oven, maintained at a temperature of 70 ± 1°C, for a period of 7 days. After expiry of seven days, remove the webbing and allow it to cool to room temperature. Examine whether the specimen is free from stickiness or gumminess and test it for breaking load, by the method given in IS 1969 : 1985.

TESTS FOR WOVEN ROVING GLASS FABRIC FOR POLYESTER GLASS LAMINATES FOR AEROSPACE PURPOSES DETERMINATION OF ROVING COUNT, FLEXURAL STRENGTH, MOISTURE CONTENT AND LOSS ON IGNITION

(*Source* : IS 10476 : 1983)

1 SCOPE

1.1 This standard prescribes methods of tests for determination of roving count, flexural strength, moisture content and loss on ignition of woven roving glass fabric for polyester glass laminates for aerospace purposes.

2 DETERMINATION OF ROVING COUNT

2.1 Maintaining a length of roving under sufficient tension to ensure that it is straight, cut off a 1-m length, measured with an accuracy of ± 1 percent.

2.2 Weigh the cut length to the nearest 5 mg and report this mass in milligrams as the roving (tex).

3 PREPARATION AND TESTING OF RESIN-GLASS FABRIC LAMINATE FOR FLEXURAL STRENGTH

3.1 General

A test laminate of 3.17 ± 0.25 mm thickness and 30 × 30 cm shall be prepared using sufficient number of glass cloth and polyester resin with a suitable catalyst and accelerator. The proportion of resin hardener and accelerator and subsequent curing of the laminate shall be in accordance with the instructions of the resin manufacturer. The glass fabric cut to size shall be dried in a ventilated oven for 1 hour at 100 ± 5°C, cooled in a desiccator and used immediately on removal. The fabric shall be impregnated with the resin to give a final resin content of 35 to 42 percent of the total weight when determined by ignition at 575 ± 25°C. The laminating shall be done at an ambient temperature of 17 to 25°C.

3.2 Preparation of Laminate

A suitable method for preparation of laminate is given in 3.2.1 and 3.2.2.

3.2.1 Calculate the mass of resin necessary to give the required resin content from the mass of glass cloth to be used. Cover a polished metal plate of size 40 × 40 cm with a layer of regenerated cellulose film of 0.05 mm thickness. Lay on it a layer of dried glass cloth of suitable size. Pour sufficient amount of catalyzed resin on to the centre of the cloth and spread out uniformly with a roller or thin metal strip until the cloth is evenly coated. Repeat the procedure with alternate layers of resin and glass cloth and with successive layers of cloth superimposed on the previous one with the warp threads parallel to those in the preceding ply. The whole process should not take more than 20 minutes.

3.2.2 Cover the top layer with a layer of regenerated cellulose fibre followed by a second polished metal plate. Place metal stops 3 mm thick between the lower and the upper metal plates. Place the whole built-up between the platens of a press and hold under a pressure of approximately 0.5 kg/cm^2 during the curing schedule. After curing the laminate in accordance with the resin manufacturer's instructions, give a postcure at 100°C for 2 hours.

3.3 Determination of Flexural Strength of Laminate

3.3.1 *Test Specimens*

Cut ten rectangular strips, measuring 100 × 15 mm, from the laminate with the longer direction parallel to the warp or weft for determining the flexural strength of the strips.

3.3.2 *Conditioning of Test Specimens*

Condition the specimens to be tested in the 'dry condition' for not less than 24 hours in an atmosphere of 65 ± 2 percent relative humidity and 27 ± 2°C temperature prior to testing, and test in the same conditions.

Immerse the specimens to be tested in the 'wet condition' in boiling distilled water for 2 hours and allow to cool to room temperature in the same water. Conduct the test on the wet specimens immediately after removal from water.

3.3.3 *Apparatus*

A suitable flexural strength testing machine with a bend jig, which will permit the span being varied to suit the thickness of the specimens, is used. The machine shall be properly calibrated and the error, if any, in the load measuring system shall not exceed ± 1 percent of the applied load. The contact surfaces of the supports and loading blocks shall be of a radius of 3.2 ± 0.2 mm and shall not be less than 25 mm in length from each end.

3.3.4 *Measurement of Dimensions*

The breadth and thickness at the centre of the span shall be measured to the nearest 0.01 mm. The span shall be measured to the nearest 0.2 mm.

3.3.5 *Procedure*

Place the specimen symmetrically over the supports in the bend jig (*see* Fig. 1) which are 50 mm apart (between 16 to 18 times the thickness of the specimen). Align the loading block and the supports so that the axes of the cylindrical surfaces are parallel and the loading block is midway between the supports. Apply the load to the specimen at a cross-head rate of 5 to 6.5 mm/min till it fractures. The load at fracture shall be noted.

3.3.6 *Calculation and Reporting*

The flexural strength or the modulus of rupture in bending is the maximum load sustained by the specimen converted to the maximum fibre stress. It is calculated using the following formula:

$$S = 15 \times \frac{wl}{bt^2}$$

where

S = flexural strength in Mn/m^2,

w = load at fracture in N,

l = span in mm,

b = breadth of the specimen in mm, and

t = thickness of specimen in mm.

3.3.6.1 The average of five determinations in each direction and tested in each state, that is, dry and wet, shall be reported as the flexural strength.

4 DETERMINATION OF MOISTURE CONTENT

4.1 Weigh to the nearest 5 mg, about 10 g of the sample. Place the sample in a force draught oven at 105 ± 2°C for 30 minutes. Reweigh the sample either without removing from the oven but with the air flow stopped, or in a stoppered container after cooling. Calculate the moisture content as follows:

$$\text{Moisture content, percent by mass} = \frac{A - B}{A} \times 100$$

where

A = original mass in g of the sample, and

B = mass in g of the oven-dried sample.

4.1.1 The dried roving shall be used for determination of loss on ignition.

5 DETERMINATION OF LOSS ON IGNITION

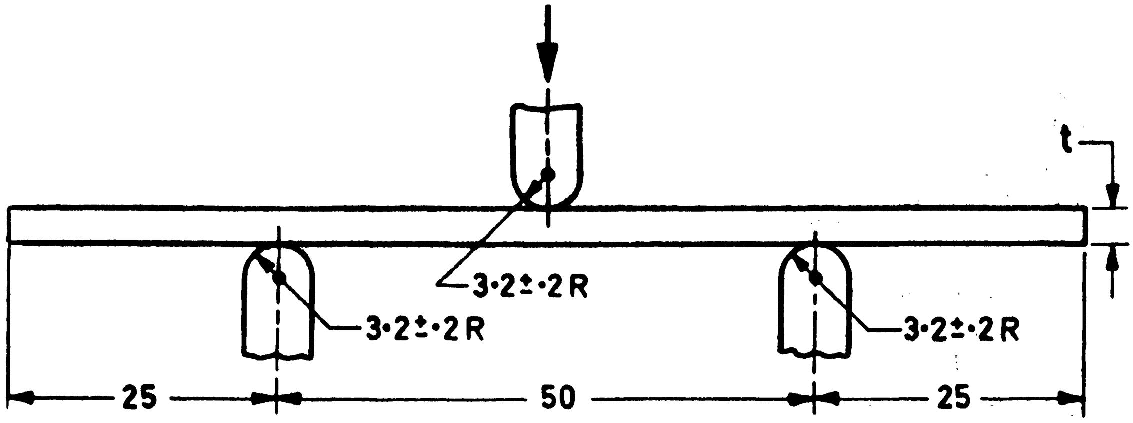
5.1 Heat the oven dried sample of the fabric obtained from the determination of moisture content (*see* 4.1.1), at 575 ± 25°C to ignite the size. Cool in a desiccator and reweigh to the nearest 5 mg. Calculate the loss on ignition as follows:

$$\text{Loss on ignition, percent by mass} = \frac{B - C}{B} \times 100$$

where

B = mass in g of the oven-dried sample, and

C = mass in g of the sample after ignition.



t — thickness of specimen

All dimensions in millimetres.

FIG. 1 FLEXURAL TEST FOR RESIN-GLASS FIBRE LAMINATE

TEST FOR CONTINUOUS FILAMENT TEXTILE GLASS YARN FOR AEROSPACE PURPOSES DETERMINATION OF DIAMETER, LINEAR DENSITY, IGNITION LOSS AND TENSILE STRENGTH

(*Source* : IS 11916 : 1986)

1 SCOPE

1.1 This standard prescribes the methods of tests for determination of diameter, linear density, ignition loss and tensile strength of continuous filament textile glass yarn for aerospace purposes.

2 DETERMINATION OF MONOFILAMENT DIAMETER

2.1 Apparatus

2.1.1 *A Projection Microscope*

Having a mangification of 1 000 × and having a movable stage on which a slide can be mounted; and capable of measuring accurate to the nearest 0.1μ m.

2.1.2 *Glass Slides*

Of size suitable for mounting on the stage of the projection microscope.

2.1.3 *Thin Glass Cover Slips*

For the slides.

2.1.4 *A Mounting Medium*

Comprising equal volumes of glycerine BP and distilled water.

2.1.5 *A Pair of Tweezers*

2.1.6 *A Glass Road*

Of 150 mm length and 3 mm or 6 mm diameter.

2.1.7 *A Wire Mesh Basket*

Approximately 100 mm × 75 mm × 25 mm size made from 1 400 mm stainless steel.

2.1.8 *A Muffle Furnace*

Capable of operating at 550 ± 25°C.

2.2 Procedure

2.2.1 Weigh a test sample of about 5 g free from foreign matter with the help of razor blades, cut the filaments into fibres of 1 cm to 2 cm size. The test sample may or may not contain a resin binder or size.

NOTE — If the test is being used to check fibre diameter in relation to a particular sliver tex then the sample shall be taken from a nominal tex package, or the actual tex shall be quoted.

2.2.2 If the sample is bonded or sized, place it in the wire mesh basket and heat it in the muffle furnace at 550 ± 25°C until all traces of binder or size are removed.

NOTE — Unbonded or unsized sample does not require this form of treatment.

2.2.3 *Preparation of Slides*

Using the glass rod, place one drop of glycerine solution on a slide.

Extract a small number of fibres from the sample using tweezers, immerse them in the glycerine drop on the slide and spread them out to cover an area approximately equal to that of the cover slip.

Place the cover slip on the top of the glycerine/fibre mixture.

Prepare sufficient number of slides to enable the total number of readings to be taken. 25 diameter readings shall be taken from each slide.

2.2.4 *Measurement of Monofilament Diameter*

2.2.4.1 Mount a slide on the microscope stage and roughly focus the image.

2.2.4.2 Move the stage in any one direction until no more fibres cross the field of vision. Then move the stage in the opposite direction until the first fibre appears at the centre of the screen. Then focus the image exactly.

2.2.4.3 Read off the diameter of monofilament to the nearest 0.5, micron using a rule graduated in 0.5 mm.

NOTE — 1 mm on the rule = 1μm filament diameter × 1 000.

2.2.4.4 Move the stage until a second fibre appears at the centre of eyepiece. Re-focus the image and read off the monofilament diameter as above.

2.2.5 *Calculation of Mean Fibre Diameter and Its Standard Deviation*

Establish the number of fibres (f_i) having an identical diameter (x_i). Multiply each diameter (x_i) by the number of fibres (f_i) of this diameter.

Calculate the mean diameter ($\bar{x}$) as follows:

$$\bar{x} = \frac{\Sigma f_i x_i}{n}$$

where

$n = \Sigma f_i$ = total number of fibres tested.

Calculate the standard deviation (S) of the frequency distribution by either of the following formulae:

$$S = \sqrt{\frac{\Sigma f_i (x_i - \bar{x})^2}{n - 1}}$$

$$S = \sqrt{\frac{1}{n - 1}\left[\frac{\Sigma f_i x_i^2 - (\Sigma f_i x_i)^2}{n}\right]}$$

3 DETERMINATION OF LINEAR DENSITY AND IGNITION LOSS OF GLASS YARNS

3.1 Definitions

3.1.1 *Linear Density*

The mass per unit length of desized oven-dried glass yarn expressed in text system.

3.1.2 *Pre-tension*

The tension applied to a yarn or roving before determining the linear density or the twist.

Value of yarn pre-tension F, applied with a tolerance of ± 10 percent, of textile glass continuous filament yarns, is given by the formula:

$$F \text{ (newtons)} = \frac{A \text{ (tex)}}{200} = \frac{A \text{ (decitex)}}{2\,000}$$

where A is the sum of the nominal linear densities of the strands constituting the yarn.

The strand pre-tension of a yarn is expressed in newtons according to Table 1.

Table 1 Strand Pre-tension

(*Clauses* 3.1.2 *and* 3.4.1)

Linear Density		Pre-tension in Newtons
Tex	Decitex	
125	1 250	0.40
190	1 900	0.50
340	3 400	0.75
680	6 800	1.00
2 000	20 000	2.00

For intermediate linear densities, calculate the normal pre-tension by interpolation.

3.2 Principle

A specimen of known length of glass yarn after desizing is calcined to constant mass at a standard temperature of 625 ± 20°C and then linear density is expressed in grams per kilometre.

NOTE — For glass yarns which are unstable at the above-mentioned temperature, a temperature between 500 and 600°C may be chosen according to glass specification or as per agreement between the buyer and the seller. The chosen temperature must be kept constant within ± 20°C tolerance.

3.3 Apparatus

3.3.1 *Muffle Furnace*

Capable of maintaining the standard temperature of 625 ± 20°C, or the chosen temperature ± 20°C.

3.3.2 *Desiccator*

Containing a suitable desiccant (for example, silica gel, calcium chloride, phosphorous pentaoxide).

3.3.3 *Specimen Holder*

3.3.4 *Stainless Steel Tongs*

3.3.5 *Balance*

Accurate to 0.1 mg.

3.3.6 *Wrap Reel*

For the unwinding of the yarn, the perimeter preferably being equal to 1 m, equipped with a revolution counter working from a set value to zero or vice-versa.

3.3.7 *Air-Ventilated Oven*

For drying the specimen, capable of being controlled at 105 ± 2°C or 80 ± 2°C or the chosen temperature ± 2°C [*see* Note under 3.5.1.2 (a)].

3.4 Test Specimen

3.4.1 From each package selected in 6.2, unwind under a standard pre-tension (*see* Table 1), taking care to avoid any modification of twist during the operation, test specimen of length given in Table 2.

For plied yarns, take the length of specimen corresponding to that of the single yarn from which it was constructed, divided by the number of ends constituting the plied yarn.

3.5 Procedure

3.5.1 Desize the test specimen (*see* 3.4.1) as described in 3.5.1.1 and 3.5.1.2.

Table 2 Length of Specimen

(*Clause* 3.4.1)

Linear Density, T_t (Tex)	Length of Yarn (m)
$T_t < 5$	2 000
$5 \leq T_t < 10$	1 000
$10 \leq T_t < 50$	500
$50 \leq T_t < 200$	100
$200 \leq T_t < 500$	50
$500 \leq T_t < 1\,000$	20
$1\,000 \leq T_t < 2\,500$	10
$2\,500 \leq T_t < 5\,000$	5
$T_t \geq 5\,000$	Length such that the mass lies between 5 g and 25 g

3.5.1.1 *Weighing of holder*

Stabilise the mass of holder by placing it in the muffle furnace controlled at a temperature of 625 ± 20°C or at the chosen temperature between 500 and 600°C (*see* 3.2). Cool the holder in the desiccator in standard atmosphere of 65 ± 2 percent relative humidity and 27 ± 2°C temperature. Weigh the holder to an accuracy of 0.001 g. Note the mass of holder (m_0) in g.

3.5.1.2 *Weighing of dried test specimen plus holder*

a) Place the test specimen on the holder.

Place the holder with the specimen in the oven, controlled at 105 ± 2°C. In the case of sized yarn, the standard temperature shall be 80 ± 2°C.

NOTE — In the case of textile glass yarns containing components which are volatile or susceptible to change at these standard temperatures, a lower temperature may be chosen by agreement between the interested parties; it shall be maintained constant to within ± 2°C.

b) Heat the specimen for at least one hour.

Remove the specimen with its holder from the drying oven and allow to cool in standard atmosphere of 27 ± 2°C temperature and 65 ± 2 percent relative humidity for 30 min. Weigh the whole (specimen + holder) and note the reading to the nearest 0.001 g as *m*1.

3.5.1.3 *Calcination of test specimen*

Place the test specimen flat on the holder and put the holder with the specimen in the muffle furnace controlled at 625 ± 20°C or at the chosen temperature between 500 and 600°C (*see* 3.2). Allow to burn for 5 minutes with the door of furnace open to allow volatile products to escape from the furnace thus preventing their redeposition on the specimen or the holder. Then close the door of the furnace and heat for a further 30 minutes. If a temperature lower than 625°C is chosen, the latter heating period should be increased to at least 1 hour. Remove the test specimen and holder from the furnace and transfer to desiccator. Allow to cool in standard atmosphere (*see* 3.5.1.1). Weigh the calcined test specimen and holder with an accuracy of 0.001 g. Note the mass of calcined test specimen and holder (m_2) in g.

3.6 Precautions During the Test Procedure

3.6.1 Ensure that the test specimen does not come into contact with the furnace during the heating state.

3.6.2 Transfer the test specimen plus holder between furnace, desiccator and balance with great care to avoid loss of material.

3.6.3 Never touch the test specimen with the fingers, but use the tongs.

3.7 Expression of Results

3.7.1 Calculate the mass m of each test specimen by the formula:

$$m = m_2 - m_0$$

3.7.1 Calculate the linear density T_t of each test specimen by the formula:

$$T_t = \frac{1\,000\,m}{l}$$

where

m = desized, oven-dried yarn mass, in g, and

l = length of yarn in the test specimen, in metres.

3.7.3 To calculate the mean actual linear density $\bar{T}_t$ of the batch or the lot, take the arithmetic mean of the linear densities T_t of the test specimens.

3.7.4 Calculate the coefficient of variation (V) by the following formula correct to one decimal place.

$$V = \sqrt{\frac{(T_t - \bar{T}_t)^2/N}{T_t}} \times 100$$

where

T_t = Measured linear density for each test specimen,

T_t = mean linear density of batch or consignment, and

N = number of test specimens tested.

3.7.5 Calculate the percentage of linear density deviation (d) by the following formula correct to one decimal place.

$$d = \left(\frac{\bar{T}_t - b}{b}\right) \times 100$$

where

T_t = mean linear density of the batch or the consignment, and

b = Standard value of linear density (*see* relevant standard).

3.7.6 Calculate the percentage ignition loss (L) of each test specimen by the formula:

$$L = \frac{m_1 - m_2}{m_1 - m_0} \times 100$$

where

m_0 = mass, in grams, of the holder;

m_1 = mass, in grams, of the holder plus dried specimen; and

m_2 = mass in grams, of the holder plus dried and calcined specimen.

3.7.7 Report

The test shall include the following particulars:

a) Actual linear densities (T_t) of all the individual test specimens;

b) The mean actual linear density ($\bar{T}_t$) of the batch or the consignment,

c) The coefficient of variation (V) of individual values for all the measurements;

d) The percentage of linear density deviation (d) of individual values for all the measurements;

e) The average ignition loss in percentage; and

f) The heating time in the oven and the temperature of the muffle furnace, if the latter differs from 625 ± 20°C.

4 DETERMINATION OF TENSILE STRENGTH

4.1 Apparatus

4.1.1 The tensile testing machine used shall include:

a) a pair of suitable clamps to grip the specimen,

b) means for elongating the specimen, and

c) a mechanism which will indicate or record the load applied to the specimen and the corresponding elongation.

4.1.2 Following types of testing machines may be used:

a) Constant rate of load,

b) Constant rate of specimen extension, and

c) Constant rate of traverse of driven clamp.

4.1.3 The testing machine shall be capable of testing specimens having a nominal gauge length of 250 ± 1 mm.

NOTE – By agreement between the interested parties, other nominal gauge length may also be used, although in these conditions the test results may be slightly different than those obtained with the gauge length of 250 ± 1 mm.

4.2 Conditioning and Testing

4.2.1 Pre-condition the packages selected by exposing in an atmosphere having temperature of 80 ± 2°C and relative humidity not exceeding 10 percent until a substantially constant mass is obtained.

4.2.2 After pre-conditioning, bring the packages selected to a state of moisture equilibrium by exposing them in a standard atmosphere of 65 ± 2 percent relative humidity and 27 ± 2°C temperature for at least 3 hours.

4.2.3 The test specimens shall be tested in a standard atmosphere given in 4.2.2.

4.3 Test Specimens

4.3.1 Take ten specimens from each package selected having a length of at least 600 mm of yarn; a length of 1 000 mm facilitates handling and preservation of twist.

The yarns to be tested shall be taken from the package in such a way as to avoid any abnormal change in twist. Preferably the yarns shall be unwound tangentially, by causing the package to rotate around its own axis, in such a way that the yarns remain constantly under tension. Remove at least the outer layer of yarn and then take five test specimens successively, each test specimen consisting of an entirely new portion of yarn; then unwind approximately 100 m of the yarn before taking the last five test specimens successively, these being made up from an entirely new portion of yarn.

4.4 Procedure

4.4.1 Check that the distance between the grips of the testing machine is 250 ± 1 mm [*see also* Note below (4.1.3)] Check that the grips are correctly aligned and parallel in such a way that the force applied to the test specimen does not produce any angular displacement of the grips.

4.4.2 After conditioning as specified in 4.2.2, grip the test specimen in tensile tester so that the axis of the test specimen is perpendicular to the edge of the clamps.

4.4.3 Apply to the test specimen a pre-tension of 5 ± 0.5 mN/tex, calculated from the nominal linear density of the yarn, unless the pre-tension extends the specimen by more than 0.5 percent in which case a lower pre-tension (for example, 2.5 mN/tex or 1 mN/tex), may be used as per the agreement between all the interested parties.

4.4.4 Set the moving clamps in motion at a test speed of 50 mm/min. After breaking of the specimen, record the maximum force and the elongation at break. Return the moving clamp to its zero position and remove the ends of the broken specimen.

4.4.5 Disregard any observation made on test specimens that slips between the jaws, or that break in, or within 10 mm of the jaws. The number of observations that are ignored shall be counted, if it exceeds 10 percent of the number of specimens tested, the clamps shall be readjusted.

4.4.6 Calculate the arithmetic mean of the individual results obtained for the breaking force and percentage elongation at break.

SECTION K

INDEX TO INDIAN STANDARDS COVERED IN THIS HANDBOOK

LIST OF INDIAN STANDARDS REFERRED

IS Number	*Title*
2 : 1960	Rules for rounding off numerical values (*revised*)
514 : 1978	Mercerized cotton fabrics for covering air crafts and gliders (*second revision*)
686:1985	Determination of colour fastness of textile materials to daylight (*first revision*)
688:1988	Determination of colour fastness of textile materials to organic solvents (*first revision*)
697 : 1963	Woollen druggets (*revised*) (with Amendments No. 1 and 2)
766:1988	Determination of colour fastness of textile materials to rubbing (*first revision*)
767:1988	Determination of colour fastness of textile materials to water (*first revision*)
1226:1957	Determination of linear density (mass per unit length) in denier units (or text units) of continuous filament rayon yarn and acetate yarn
1670:1970	Determination of breaking load, elongation at break and tenacity of yarns (*first revision*)
1719 : 1979	Pressed wool felt (*third revision*)
1969:1985	Determination of breaking load and elongation of wooven textile fabrics (*second revision*)
2198 : 1971	Flax webbing for aeronautical purposes (*first revision*)
2454:1985	Determination of colour fastness of textile materials to artificial light (Xenon lamp) (*first revision*)
3244 : 1965	Cotton webbing, statichute
3262 : 1987	Pilot lead line (*first revision*)
3689 : 1966	Conversion factors and conversion tables for yarn counts
4229 : 1978	Nylon sewing threads for aerospace purposes (*first revision*) (with Amendment No. 1)
4392 : 1967	Hand-made *NAMDHAS* (with Amendments No. 1 and 2)
4719 : 1984	Wire-woven rayon fabric for aerospace purposes (*second revision*)
4727 : 1968	Nylon webbing for aeronautical purposes
4910 (Part 2) : 1989	Methods of test for tyre yarns, cords and tyre cord warp sheets made from man-made fibres : Part 2 Linear density (*first revision*)
4910 (Part 3) : 1989	Methods of test for tyre yarns, cords and tyre cord warp sheets made from man-made fibres : Part 3 Load and elongation characteristics (*first revision*)
4910 (Part 4) : 1989	Methods of test for tyre yarns, cords and tyre cord warp sheets made from man-made fibres : Part 4 Dip pick up (*first revision*)
4910 (Part 5) : 1989	Methods of test for tyre yarns, cords and tyre cord warp sheets made from man-made fibres : Part 5 Heat shrinkage and heat shrinkage force (*first revision*)
4910 (Part 6) : 1989	Methods of test for tyre yarns, cords and tyre cord warp sheets made from man-made fibres : Part 6 Wet contraction and wet contractile force (*first revision*)
4910 (Part 7) : 1989	Methods of test for tyre yarns, cords and tyre cord warp sheets made from man-made fibres : Part 7 Heat degradation (*first revision*)
4910 (Part 8) : 1989	Methods of test for tyre yarns, cords and tyre cord warp sheets made from man-made fibres : Part 8 Thickness (*first revision*)
4910 (Part 10) : 1989	Methods of test for tyre yarns, cords and tyre cord warp sheets made from man-made fibres : Part 10 Creep (*first revision*)
4910 (Part 11) : 1989	Methods of test for tyre yarns, cords and tyre cord warp sheets made from man-made fibres : Part 11 Commercial mass (*first revision*)

IS Number	*Title*
5450 : 1986	Gloves, wool, knitted (*second revision*)
5641 : 1973	Hand-made wool carpets (*first revision*)
5746 (Part 1) : 1987	Woven glass fibre fabrics for plastic laminates for aerospace purposes : Part 1 Loom-state fabric (*second revision*)
5746 (Part 2) : 1987	Woven glass fibre fabrics for plastic laminates for aerospace purposes : Part 2 Desized fabric (*second revision*)
5746 (Part 3) : 1987	Woven glass fibre fabrics for plastic laminates for aerospace purposes : Part 3 Finished fabrics for use in Polyester resin system (*second revision*)
5815 (Part 1) : 1971	Methods of test for fishing gear materials : Part 1 Determination of thickness
5815 (Part 2) : 1970	Methods of test for fishing gear materials : Part 2 Determination of linear density (mass per unit length)
5815 (Part 3) : 1970	Methods of test for fishing gear materials : Part 3 Determination of twist
5815 (Part 4) : 1971	Methods of test for fishing gear materials : Part 4 Determination of breaking load and knot breaking load
5815 (Part 5) : 1971	Methods of test for fishing gear materials : Part 5 Determination of mesh breaking load
5815 (Part 6) : 1981	Methods of test for fishing gear materials : Part 6 Determination of change in length of netting yarns after immersion in water
5815 (Part 7) : 1986	Methods of test for fishing gear materials : Part 7 Determination of elongation of netting yarns
5815 (Part 8) : 1988	Methods of test for fishing gear materials : Part 8 Determination of sinking speed
5884 : 1987	Tufted wool carpets (*first revision*)
6193 : 1971	Methods of tests for monoaxially oriented high density polyethylene/polypropylene tapes (with Amendments No. 1 and 2)
6359 : 1971	Method for conditioning of textiles
6668 : 1972	Method for preparing test specimens from fabric samples for physical tests
7071 (Part 2) : 1974	Methods of physical test for ropes and cordages – Mass, length and linear density (*first revision*)
7071 (Part 3) : 1974	Methods of physical test for ropes and cordages – Diameter, circumference and lay (*first revision*)
7071 (Part 4) : 1986	Methods of physical test for ropes and cordages – Breaking load and elongation at break (with Amendment No. 1)
7877 (Part 2) : 1976	Methods of sampling and tests for hand-made carpets – Determination of type of knots
7877 (Part 3) : 1976	Methods of sampling and tests for hand-made carpets – Determination of number of knots
7877 (Part 4) : 1976	Methods of sampling and tests for hand-made carpets – Determination of pile height
7877 (Part 5) : 1976	Methods of sampling and tests for hand-made carpets – Determination of dimensions
7878 : 1975	Hand-made broadloom roll carpets
8391 : 1987	Rubberized coir sheets for cushioning (*first revision*)
8947 : 1978	Material (nylon webbing) for aircraft safety belts
9022 : 1979	Methods for preparation of laboratory test samples and test specimens of textile materials for chemical testing
9945 : 1981	Method for determination of cutting rate
10055 : 1982	Jute needle loom felts

IS Number	*Title*
10476 : 1983	Woven roving glass fabric for polyester glass laminates for aerospace purposes
11057 : 1984	Industrial safety nets
11420 (Part 1) : 1985	Coir mats – General requirements.
11471 : 1985	Method for determination of dimensional changes due to the effects of varied water and heat conditions for machine-made carpets
11521 : 1985	Cargo handling nets
11916 : 1986	Continuous filament textile glass yarn for aerospace purposes
SP 11 : 1973	Recommended SI units for textiles